This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

T
171
.H34

DESCRIPTION

OF THE

LAWRENCE SCIENTIFIC SCHOOL

OF

HARVARD UNIVERSITY.

CAMBRIDGE, MASS.:
Published by the University.
1893.

DEPARTMENTS OF HARVARD UNIVERSITY.

The University comprehends the following departments:—

HARVARD COLLEGE,
THE LAWRENCE SCIENTIFIC SCHOOL,
THE GRADUATE SCHOOL,
THE DIVINITY SCHOOL,
THE LAW SCHOOL,
THE MEDICAL SCHOOL,
THE DENTAL SCHOOL,
THE SCHOOL OF VETERINARY MEDICINE,
THE BUSSEY INSTITUTION (a School of Agriculture),
THE ARNOLD ARBORETUM,
THE UNIVERSITY LIBRARY,
THE MUSEUM OF COMPARATIVE ZOÖLOGY,
THE UNIVERSITY MUSEUM,
THE BOTANIC GARDEN,
THE HERBARIUM,
THE ASTRONOMICAL OBSERVATORY.

THE PEABODY MUSEUM OF AMERICAN ARCHAEOLOGY AND ETHNOLOGY is a constituent part of the University; but its relations to it are affected by peculiar provisions.

THE FACULTY OF ARTS AND SCIENCES

Comprehends:—

HARVARD COLLEGE,
THE LAWRENCE SCIENTIFIC SCHOOL,
THE GRADUATE SCHOOL.

PRELIMINARY NOTE.

The Lawrence Scientific School, together with Harvard College and the Graduate School, is under the control of the Faculty of Arts and Sciences of Harvard University. The instruction in these departments is given by the same teachers, mostly in classes which may be attended by pupils from any one of these schools. The life of the students in all three departments is in common; they share alike in all the advantages which the academic department of the University can afford them. So far as their plans may make it desirable, they are allowed without additional charge to attend lectures in the Professional Schools of the University.

The essential peculiarity of the Scientific School as compared with the other schools which are managed by the Faculty of Arts and Sciences is that the instruction which it provides for its students is arranged in groups of definite required courses or departments, each of which is intended to afford in a four years' course of study a training in some portion of natural science which may be made the basis of a profession. While, with the consent of the Administrative Board of the School, changes may be made in any of the prescribed courses in order to meet the particular needs of the individual student, the plan of these courses leading to the degree of Bachelor of Science must in general be adhered to. Students are, however, permitted, without additional charge, to attend any other instruction in addition to their required work which they may be fitted to pursue, except the exercises in special laboratories.

Advantages of the School.

The School is a constituent part of Harvard University, and as such has the general advantages afforded by that institution. It is situated in Cambridge, a city of about eighty thousand inhabitants, at a distance of three miles from Boston, Mass. The City of Cambridge occupies a wholesome territory, and its sanitary state is good; it has been remarkably exempt from contagious diseases; during the several epidemics of cholera which have affected this country, the malady has appeared in but one household. In the census of 1880, it held the first place as regards healthfulness in the list of forty-three cities. The College buildings, including the dormitories, are subjected to a careful sanitary inspection.

NIVERSITY INSTITUTIONS.

The I iversity contain 395,970 bound volumes, and an
equal s and maps. In Boston, the collections of the
Publ eum, the Boston Society of Natural History,

and other institutions accessible to students, contain a yet larger total number of books.

The University maintains the following scientific establishments and museums: A general establishment, known as the University Museum, which contains the collections and laboratories belonging to the departments of Zoölogy, Botany, Geology, and Mineralogy, and has a floor area of four acres, excluding entries and staircases; an Astronomical Observatory; a Museum of American Archaeology; a Semitic Museum; a Botanic Garden and Herbarium, the former occupying an area of about seven acres of land and exhibiting more than five thousand species of flowering plants; a series of Chemical Laboratories, which occupy the whole of Boylston Hall, and which provide instruction in the various branches of that science; the Jefferson Physical Laboratory and Museum of Apparatus for instruction in the departments of light, heat, electricity, etc.; a work-shop devoted to instruction in Applied Electricity; a Physiological Laboratory for researches and instruction in the course on Anatomy, Physiology, and Physical Training; a Laboratory of Psychology. The extensive laboratories of the Medical, Dental, and Veterinary Schools are situated in Boston; the Bussey School of Agriculture and the Arnold Arboretum, in West Roxbury, about six miles south of Cambridge.

For the Physical Culture of the students, the University has provided the following establishments: The Hemenway Gymnasium for in-door exercises and instruction in physical culture; the Carey Building for the training of those who may undertake competitive exercises; two boat houses on the banks of the Charles River, in the immediate neighborhood of the College grounds; four fields for athletic sports and exercises, containing a total area of about one hundred acres.

The positions of the buildings and grounds in Cambridge are indicated on the accompanying map.

Students attending the Cambridge departments of the University may lodge in the dormitories, which are the property of the University, and which contain an aggregate of about 550 rooms, or in private houses, a list of which will be sent on application to the Secretary of the University; they may take their meals either in Memorial Hall, which affords accommodations for about 1100 persons; in the Foxcroft Club, which provides places for about 250; or in private boarding houses.

Each student in the Scientific School has one of its officers designated as his adviser, to whom he is to look for counsel concerning the conduct of his studies and such other assistance as he may need during his residence at the University.

Students who are candidates for a degree may enter the School by passing the required examinations (see page 13).

Persons of sufficient maturity and education who may not pass the entrance examinations, but who intend, so far as their previous training may admit, to pursue a course of study, in general corresponding to one of the departments of the School, or who may desire to devote their time to some special branch of natural science, are admitted without examination. Such persons are not ranked as candidates for a degree.

Admission from Other Schools.

Students of other institutions who have pursued courses in general parallel to those required in any department of the Lawrence Scientific School, may be admitted to advanced standing on conditions to be determined by a committee of the Faculty appointed for that purpose. Application for such transfer should be made to the Dean.

Summer Schools.

The University maintains a number of summer courses in science and languages which can be substituted for the corresponding work in the regular terms in the Lawrence School. By the use of the opportunities which these summer schools afford, it is possible for the student, who is well prepared at the time of his admission, to complete the course in three years. The following is the list of the courses given during the summer of 1892: —

Chemistry, four courses, viz.: Fundamental Principles of Chemistry; Qualitative Analysis; Quantitative Analysis; Organic Chemistry.
Botany, two courses, viz.: Vegetable Morphology and Physiology and Microscopical Anatomy of Phaenogams; Cryptogamic Botany.
Engineering, three courses, viz.: Topographical Surveying; Railway Surveying; Electrical Engineering.

Physics, two courses.
Physical Training, two courses.
American History.
Trigonometry.
English.
French, two courses.
Elocution.
Courses at the Medical School.
Geology, three courses.
Physiology and Hygiene.
Socialism and Social Problems.
Horticulture.
German, two courses.
History and Art of Teaching.
Draughting & Descriptive Geometry.

Religious Advantages.

The religious instruction of the University is committed to a board of preachers, of which the Plummer Professor of Christian Morals is the chairman. The other members are appointed from year to year from the clergy of the several Protestant denominations. In the academic year 1891-92, the annual appointments included: Lyman Abbott, D.D. (Brooklyn, N. Y.), Charles Carroll Everett, D.D. (Cambridge, Mass.), Brook Herford, D.D. (Boston, Mass.), Leighton Parks, A.M., D.B. (Boston, Mass.), Henry Van Dyke, D.D. (New York, N. Y.).

Each of these preachers to the University is a resident in Cambridge for about six weeks in the year, during which he conducts morning prayers, preaches on Sunday evenings, and is in attendance at Wadsworth House 1, at the service of any student who may desire to consult him.

In addition to the opportunities for worship in Appleton Chapel, seats are provided for students, at the expense of the University, in the churches of the different denominations in Cambridge.

THE LAWRENCE SCIENTIFIC SCHOOL.

ADMINISTRATIVE BOARD.

NATHANIEL S. SHALER, S.D., *Dean, and Professor of Geology.*
HENRY B. HILL, A.M., *Professor of Chemistry.*
WILLIAM H. BURR, C.E., *Professor of Engineering.*
EDWIN H. HALL, PH.D., *Assistant Professor of Physics.*
HANS C. G. VON JAGEMANN, PH.D., *Assistant Professor of German.*
PAUL H. HANUS, S.B., *Assistant Professor of the History and Art of Teaching.*
JOHN E. WOLFF, PH.D., *Assistant Professor of Petrography.*

COMMITTEE OF ADVISERS.

NATHANIEL S. SHALER, S.D., *Dean, and Professor of Geology.*
WILLIAM H. BURR, *Professor of Civil Engineering.*
ROBERT W. WILLSON, PH.D., *Instructor in Astronomy and Physics.*
GEORGE W. FITZ, M.D., *Instructor in Astronomy and Physiology.*
JOHN C. WAIT, M.C.E., L.L.B., *Instructor in Surveying and Drawing.*
COMFORT A. ADAMS, JR., S.B., *Instructor in Electrical Engineering.*

COMMITTEE ON ADMISSION FROM COLLEGES AND SCIENTIFIC SCHOOLS.

N. S. SHALER, W. H. BURR,
P. H. HANUS.

STUDENTS.

DEPARTMENT OF CIVIL AND TOPOGRAPHICAL ENGINEERING.

Adams, Frank William,	1	*Newtonville,*	52B Kirkland St.
Baker, Morris,	*S.*	*Philadelphia, Pa.*	381 Harvard St.
Blye, Joseph Napoleon,	1	*New York, N. Y.*	6 Mt. Auburn St.
Cassidy, David Demarest, Jr.	2	*Amsterdam, N. Y.*	M. 38.
Clarke, John Gray,	*S.*	*Globe Village,*	40 Kirkland St.
Cushman, Victor Nelson,	*S.*	*St. Louis, Mo.*	100 Mt. Auburn St.
Diaz, Manuel Dionisio,	*S.*	*Havana, Cuba,*	738 Main St.
Dodd, Arthur Adrian,	*S.*	*Warrensburg, Mo.*	9 De Wolff St.
Fletcher, Austin Bradstreet,	4	*North Cambridge,*	35 Blake St.
Gade, John Allyne,	1	*Christiania, Norway.*	5 Berkeley St.

Gordon, George Byron,	S.	*New Perth, P. E. I.*	1 Trowbridge Ter.
Hatton, Charles Francis,	S.	*Charlestown,*	358 Bunker Hill St., Charlestown.
Hauck, William,	1	*Watertown,*	Watertown Arsenal.
Henry, George Stuart,	1	*Denver, Col.*	Felton Building 34.
Highlands, John Ashley,	4	*Fall River,*	404 Harvard St.
Hosmer, Ralph Sheldon,	S.	*Dorchester,*	361 Neponset Av., [Dor.
Johnson, Arthur Newhall,	3	*Lynn,*	D. 27.
Kane, John Kent,	S.	*Wilmington, Del.*	W. H. 49.
Kline, Robert Everett,	3	*Dayton, O.*	40 Mt. Auburn St.
Lane, Carleton Cushing,	S.	*Quincy,*	18 Story St.
Lewis, Kennett Hastings	S.	*Rolinsford, N. H.*	Little's Block 29.
Lloyd, Henry Burroughs, A.B. 1892,	4	*Philadelphia, Pa.*	381 Harvard St.
Lyman, Charles Frederick,	1	*Boston.*	Hilton Block 10.
McCarthy, Edward Eugene,	S.	*West Somerville,*	15 Linden Ave.
Macurdy, John Ordway,	1	*Watertown,*	41 Fayette St., Watertown.
Merryweather, Arthur Marwood,	1	*Chicago, Ill.*	1689 Cambridge St.
Palmeter, George Fitch,	2	*Chicago, Ill.*	1689 Cambridge St.
Perry, Chauncy Rusch,	1	*New Ipswich, N. H.*	90 Hammond St.
Russell, Wallace Byrne,	S.	*Short Hills, N. J.*	18 Story St.
Saldana, Manuel Arturo,	S.	*St. John, Porto Rico,*	44 Langdon St.
Saxman, Charles Warren,	2	*Latrobe, Pa.*	Felton Building 1.
Smith, Walter Tennie,	S.	*Pepperell,*	Man. Training Sch.
Sterling, Robert Dutcher,	1	*St. Louis, Mo.*	44 Brattle St.
Swendsen, George Lewis,	2	*Richmond, Utah,*	46 Russell St.
Swords, William Voorhis,	1	*New York, N. Y.*	6 Mt. Auburn St.
Tilden, Charles Joseph,	1	*Milton,*	69 Oxford St.
Wentz, Daniel Bertsch,	S.	*Mauch Chunk, Pa.*	40 Kirkland St.
Whiting, Howard Earle,	2	*Cambridge,*	11 Ware St.
Whittren, Jacob Potter,	2	*Willimantic, Conn.*	C. 7.
Young, Harry James,	2	*Boston,*	C. 26.

DEPARTMENT OF CHEMISTRY.

Bell, Stoughton,	1	*Cambridge,*	164 Brattle St.
Booth, William Miller, Jr.	4	*Clayville, N. Y.*	96 Chandler St., [Boston.
Hilliard, Haven Johnstone,	S.	*Boston,*	D. 5.
Welch, Horace Herbert,	S.	*Wichita, Kas.*	16 Dunster St.
Whiteside, George Shattuck,	2	*Champlain, N. Y.*	18 Plympton St.
Whitridge, Andrew Henderson,	3	*Baltimore, Md.*	96 Prescott St.
Widtsoe, John Andreas,	2	*Logan City, Utah,*	46 Russell St.
Winslow, Andrew Nickerson,	S.	*Boston,*	Shepherd Block 12.

DEPARTMENT OF GEOLOGY.

Berry, Shaler,	4	*Newport, Ky.*	Shepherd Block.
Brooks; Alfred Halse,	2	*Newburgh, N. Y.*	404 Harvard St.
Curtis, George Carroll,	*S.*	*Brooklyn, N. Y.*	101 Hammond St.
Easton, Norman Salisbury,	*S.*	*Fall River,*	W. H. 32.
Fairchild, Charles Nelson,	*S.*	*Boston,*	H'ke 2.
Folsom, Grosvenor,	*S.*	*Jamaica Plain,*	26 Holyoke St.
Fox, Richard Talbot,	*S.*	*Paris, Ky.*	M. 10. [Ave.
Gardner, John Lowell, 2d,	*S.*	*Boston,*	51 Commonwealth
Hinckley, Frank Caspar,	*S.*	*Bangor, Me.*	16 Oxford St.
Holland, James Edwin,	*S.*	*Cincinnati, O.*	880 Main St.
Julbe, Julio Juan,	2	*New York, N. Y.*	Felton Building 24.
Keeler, Henry Hawley,	2	*Ridgefield, Conn.*	44 Mt. Auburn St.
Lewis, Joseph Valney,	4	*Darlington, N. C.*	22 Mt. Auburn St.
Lighthall, Frederick Stanley,	1	*Syracuse, N. Y.*	7 Linden St.
MacKaye, James Medbery,	*S.*	*Shirley,*	D. 35.
Merrill, James Andrew,	4	*Kearney, Mo.*	C. 3.
Neff, Richard Wayne,	*S.*	*Cincinnati, O.*	Shepherd Block 2.
Newman, Henry Levi, Jr.	3	*Joplin, Mo.*	W. H. 27.
Page, Logan Waller,	2	*Cambridge,*	Felton Building 14.
Read, Motte Alston,	*S.*	*Houston, Tex.*	S. 22.
Sears, John Henry,	*S.*	*Salem,*	7 Orn Sq., Salem.
Tanner, Caleb,	*S.*	*Provo City, Utah,*	46 Russell St.
Turnbull, Davis Francis,	2	*New York, N. Y.*	D. 28.
Wardner, Allen,	2	*Windsor, Vt.*	28 Holyoke St.
Woodman, Edmund Joseph,	1	*Denver, Col.*	14 Oxford St.
Worden, John Lorimer,	*S.*	*New York, N. Y.*	Brewer's Block 9.

DEPARTMENT OF BIOLOGY.

Davis, Fellowes, Jr.	2	*New York, N. Y.*	Reads Block 14.
Davis, George Adams,	2	*Worcester,*	H'ke 49.
Fernald, Merritt Lyndon,	*S.*	*Orono, Me.*	43½ Langdon St.
Folsom, Justus Watson,	3	*South Boston,*	909 Broadway, S. B.
Hobson, Willis Sanford,	*S.*	*Lakewood, O.*	14 Mellen St.
Judd, Sylvester Dwight,	3	*West Orange, N. J.*	T. 24.
Reagh, Arthur Lincoln,	3	*West Roxbury,*	Maple St., W. Rox.
Sornborger, Jewell David,	*S.*	*Cambridge,*	45 Sacramento St.
Wadsworth, James S.	2	*Genesio, N. Y.*	Beck Building 5.
Walker, Ernest Linwood,	*S.*	*Yarmouth, Me.*	310 Washington St.,
Wilson, Charles Crawford,	2	*Salina, Ill.*	G. 34. [Boston.
Wood, Albert Bowman,	3	*Worcester,*	M. 34.

DEPARTMENT OF ELECTRICAL ENGINEERING.

Baker, Malcolm Harlow	1	*Boston,*	134 W. Chester Pk.
Bancroft, Alvin Warren,	2	*Gardner,*	C. 45.
Brainard, Horace Bright,	*S.*	*Thompsonville, Conn.*	C. 21.
Browne, Jacob H.	1	*Jeffersonville, Ind.*	6 Story St.
Bubb, Clarence Eugene,	*S.*	*Williamsport, Pa.*	W. H. 61.
Bull, Robert Wilson,	1	*Buffalo, N. Y.*	3 Sumner St.
Busch, George Matthias,	*S.*	*Buffalo, N. Y.*	69 Oxford St.
Chamberlin, John Bigelow,	1	*Boston,*	64 Huntington Ave.
Clark, William Edwin,	2	*St. Albans, Vt.*	C. 2.
Day, Paul,	1	*Cambridge,*	14 Centre St.
Eaton, Joseph Jordan,	1	*Atlantic,*	1303 Washington St., Boston.
Eveleth, Charles Mirick,	2	*Cambridge,*	18 Martin St.
Flammer, Charles Arthur,	*S.*	*New York, N. Y.*	290 Harvard St,
Fraprie, Frank Roy,	1	*Fall River,*	45 Mt. Auburn St.
Gray, Guthrie,	*S.*	*Buffalo, N. Y.*	56 Mt. Auburn St.
Handy, William Byron,	*S.*	*Boston,*	585 Tremont St., Boston.
Lee, Carlton Howard,	1	*Boston,*	20 Prescott St.
McKean, Frederick George, Jr.	1	*Washington, D. C.*	5 Lee St.
Meadows, Harold Gregory,	4	*Buffalo, N. Y.*	H'ke 20.
Mills, Charles Wilson,	2	*Mt. Palatine, Ill.*	H. 23.
Morton, Alex Amerton,	1	*Wakefield,*	Wakefield.
Pierpont, Lawrence,	1	*Chicago, Ill.*	49 Oxford St.
Raudenbush, Harry William,	2	*Reading, Pa.*	18 Sumner St.
Selfridge, Harold,	1	*Boston,*	Hilton Block B.
Slade, Edward,	2	*Chestnut Hill,*	60 Mt. Auburn St.
Stevens, Cabot,	2	*Cambridge,*	26 Gray St.
Stevens, Samuel Barron,	*S.*	*Rome, N. Y.*	Copley Sq. Hotel, [Boston.
Vaughan, John Fairfield,	2	*Cambridge,*	7 Brewster St.
White, Otis Converse, Jr.	1	*Worcester,*	20 Holyoke St.
Whiting, Stephen Edgar,	1	*Cambridge,*	11 Ware St.
Woodward, Francke Leonard,	1	*Albany, N. Y.*	13 Kirkland Pl.

DEPARTMENT OF GENERAL SCIENCE.

Abbott, Allan,	1	*Watertown,*	M. 28.
Aguilar, Ramón,	*S.*	*San José, Costa Rica,*	12 Story St.
Attwill, William H,	*S.*	*Boston,*	68 Pinckney St.
Boulton, Stanton Stockwell,	*S.*	*Greenfield, Ill.*	S. 23.
Burditt, George Lovell,	4	*Cambridge,*	31 Lee St.
Carty, Harry Jerome,	*S.*	*Philadelphia, Pa.*	14 Warland St.
Cassatt, Robert Kelso,	2	*Haverford, Pa.*	68 Mt. Auburn St.

Cook, Allen,	S.	*Fall River,*	T. 58.
Cowdin, Elliot Channing,	1	*New York, N. Y.*	50 Boylston St.
Crocker, Paul,	1	*Fitchburg,*	Shepherd Block 3.
Davis, Owen Gould,	S.	*Middlesboro, Ky.*	H. 24.
Devereaux, Edward Miffirn,	S.	*Cambridge,*	124 Oxford St.
Doyle, William Edward,	S.	*Cambridge,*	1501 Cambridge St.
Drummond, Edward Augustus,	S.	*Brookline,*	50 Kirkland St.
Farovid, John Raser,	1	*Chicago, Ill.*	61 Oxford St.
Flynn, Edward James,	S.	*Somerville,*	W. 18.
Forman, George Alfred,	1	*Buffalo, N. Y.*	3 Sumner St.
Friedberg, Harry,	S.	*Kansas City, Kas.*	20 Trowbridge St.
Gosline, William Alonzo, Jr.	1	*Toledo, O.*	Reservoir St.
Harris, James Russell, Jr.	1	*Philadelphia, Pa.*	371 Harvard St.
Harrison, Noble Crain,	S.	*Williamsport,*	Brewer's Block.
Hayden, Charles Leverett,	1	*Columbus, O.*	Hilton Block 39.
Hayward, Walter Barrows,	S.	*Taunton,*	10 Hilliard St.
Holmes, Frederic Harper,	3	*Plymouth,*	W. 54.
Huidekoper, Earle Calhoun,	S.	*Meadville, Pa.*	Read's Block 28.
Hunter, James Albert,	S.	*Cambridge,*	11 Appian Way.
Hurley, Edward Martin,	S.	*Lynn,*	408 Harvard St.
Loomis, Herbert Norton,	S.	*Liberty Hill, Conn.*	52 Kirkland St.
Lynch, Daniel Edgar,	S.	*Albany, N. Y.*	Felton Building 36.
Maury, John William Draper,	S.	*Waltham,*	Waltham.
Mayhew, Bartlett,	S.	*North Tisbury,*	12 Park St., Somerville.
Moore, William Charles,	4	*East Boston,*	140 Webster St.
Morse, Henry Warren,	S.	*Salem,*	16 Oxford St.
Moss, Robert Thomas Woodward,	2	*New York, N. Y.*	894 Main St.
Mumford, Gurdon Saltonstall,	1	*New York, N. Y.*	25 Holyoke St.
Norton, Eckstein,	S.	*New Brighton, N. Y.*	Little's Block 28.
Parker, Edward Graham,	S.	*Auburndale,*	Auburndale,
Pierce, Clay Arthur,	1	*St. Louis, Mo.*	Beck Building 46.
Quinn, Albert William,	S.	*Cambridge,*	180 Lake View Ave.
Richardson, George Burr,	S.	*New York, N. Y.*	17 Mt. Auburn St.
Riker, John Lawrence, 2d,	1	*New York, N. Y.*	8 Prescott St.
Russell, Warren Dunton,	S.	*Lawrence,*	16 Oxford St.
Smith, Joseph Frailey,	S.	*Philadelphia, Pa.*	44 Brattle St.
Snyder Reginald Clare,	1	*Findlay, O.*	6 Mt. Auburn St.
Sturgis, James McCulloh,	S.	*Manchester,*	Little's Block 24.
Teung, Chan Loon,	S.	*Canton, China,*	15 Avon St.
Tilden, Irving Niles,	1	*New Bedford,*	H. 26.
Tudor, William, Jr.	1	*Temple, Ga.*	56 Mt. Auburn St.
Weitzel, George Thomas,	S.	*Frankfort, Ky.*	52 Irving Terrace.
Worman, Ben James,	2	*New York, N. Y.*	10 Oxford St.

DEPARTMENT OF ANATOMY, PHYSIOLOGY, AND PHYSICAL TRAINING.

Adams, Charles Erastus,	1	*Newtonville,*	52B Kirkland St.
Bullard, Charles,	*S.*	*Somerville,*	3 Park St., Somerville.
Edwards, Harold,	1	*Boston,*	108 Mt. Vernon St.
Hardon, Kenneth Wilson,	2	*Newton,*	50A Kirkland St.
Jeardeau, Allan W.	1	*Platteville, Wis.*	13 Mt. Auburn St.
Jones, James Francis, v.s. (*Ontario Veterinary Coll.*) 1886, s.b. (*Marietta Coll.*) 1892,	4	*Granville, O.*	56 Mt. Auburn St.
Loring, Lindsley,	1	*Brookline,*	Shepard St.
Manahan, Thomas James,	*S.*	*Boston,*	14 Newbury St., Boston.
Sands, Edward Parker,	*S.*	*Boston,*	91 Worcester St.
Tarbox, John Watson,	*S.*	*Nashville, Tenn.*	20 Berkeley St.
Terry, Frank Ernest,	*S.*	*New York, N. Y.*	38 North Ave.
Thayer, Stephen Van Rensselaer,	2	*Boston,*	Beck Building 34.
Wales, Ernest deWolfe,	*S.*	*Braintree,*	Felton Building 20.
Wing, William Arthur,	*S.*	*New Bedford,*	10 Concord Ave.

SUMMARY.

FOURTH YEAR STUDENTS	11
THIRD " "	9
SECOND " "	32
FIRST " "	48
SPECIAL "	81
Total	181

CIVIL ENGINEERING	40
CHEMISTRY	8
GEOLOGY	26
BIOLOGY	12
ELECTRICAL ENGINEERING	31
GENERAL SCIENCE	50
PHYSICAL TRAINING	14
Total	181

THE SCIENTIFIC SCHOOL.

REQUIREMENTS FOR ADMISSION.

All candidates for admission must furnish testimonials of their good moral character. These testimonials should be forwarded through the mail by their writers to the Dean of the School.

Candidates for admission to any one of the regular courses in Engineering, Chemistry, Geology, Biology, Electrical Engineering, General Science, or Anatomy, Physiology, and Physical Training, will be examined in the following subjects: —

1 (2). History of the United States and England (including Historical Geography).

The following works will serve to indicate the amount of knowledge demanded in this subject: Higginson's Young Folks' History of the United States (to the end of Chapter XXI.), and Johnston's History of the United States for Schools (beginning at § 269); Guest and Underwood's Handbook of English History (to the year 1793).

The following selections are recommended for additional reading, and will be made the basis of optional questions in the examination*: —

For American History: Lodge's English Colonies, Chapters II. and XXII.; Morse's John Quincy Adams, Chapters II. and III.; Josiah Quincy's Figures of the Past.

For English History: Macaulay's History of England, Chapters I. and III.

The requirement in history is intended to call for a substantial piece of work, equal to that demanded in any other subject occupying one hour on the examination programme. The books named in the above list to "indicate the amount of knowledge demanded" represent the minimum of fact which a candidate is expected to master. The preparation should be such as to enable the pupil to use his facts. The "additional readings" are therefore particularly recommended, showing how to reason from facts, and the larger the amount of reading which is thoughtfully done, the greater will be the number of things which the pupil remembers because he is interested in them. The best method of instruction is to use a text-book as a guide, and to require pupils from day to day to read the "additional readings" and like works giving other accounts of the same events or institutions. Care should be taken that pupils should remember the ideas of the books, but state them in their own words. Much may be accomplished by distributing topics among the members of the class for special preparation, the best of them to be reported to the class. In such cases the teacher should take care that every pupil masters also the general lesson. The teacher will find it useful to his pupils frequently to set them questions, so put as to make each one think about and combine for himself the facts with which he is dealing. Answers should be written. Candidates studying by themselves should read text-books and additional readings carefully, trying to bring together from memory the causes and results of events mentioned. The geography may best be learned by the use of outline maps, boundaries being drawn and places located from memory.

---

* Candidates who take the questions on the Selections will be allowed to omit some of the questions on the corresponding Manual.

2. *Mathematics.* — (*a*) Algebra, through Quadratic Equations. (The requirement in Algebra embraces the following subjects: factors, common divisors and multiples, fractions, ratios and proportions; negative quantities and the interpretation of negative results; the doctrine of exponents; radicals and equations involving radicals; the binomial theorem for positive integral exponents and the extraction of roots; putting questions into equations, and the reduction of equations; the ordinary methods of elimination, and the solution of both numerical and literal equations of the fiirst and second degrees, with one or more unknown quantities, and of problems leading to such equations.)

(*b*) Plane Geometry.

A thorough, practical acquaintance with ordinary arithmetic is assumed as underlying all preparation in mathematics. But no examination is held in arithmetic; and students are advised not to waste their time on merely puzzling problems, which can be better solved by algebra, or on the details of commercial arithmetic. The "four rules," the operations on vulgar and decimal fractions, the simpler reductions and combinations of compound numbers, and the extraction of the square root ought, however, to be thoroughly understood, in such a manner as to be easily and accurately worked out; for these afford the necessary basis of mathematical knowledge.

The examinations in algebra and geometry require not only accurate knowledge of those subjects, but the practical power to use that knowledge in the solution of *new problems and examples.* Memory is indispensable here as elsewhere; but in mathematics, its part should be as small as possible.

The student should strive to attain a firm hold of the *reasons* involved in the demonstrations, solutions, constructions, rules, and methods presented to him; to remember those reasons through the force with which they are impressed on his mind; and to remember the details of his subject, because he remembers their reasons. This requires earnest, patient, concentrated study; but the habit once formed, mathematics becomes easy, and the student can enter a mathematical examination with confidence. Any reputable text-books, if they are well provided with examples and problems, and cover the whole ground required, may be employed.

The list of subjects in algebra, given above, should be carefully considered; and the student should not fail to cover the whole ground there specified. A large number of examples should be solved; so that the student may learn to do his work with reasonable quickness, as well as with clearness, facility, and exactness. The examination aims to test all these qualities. The solution of tolerably complicated literal quadratics; the various methods of eliminations, for equations of the first two degrees; the putting of problems, in a neat manner, into equations; the working of all the algebraic operations both for integral and for fractional expressions, — may be specially pointed out as important subjects of attention. The student should learn to arrange his work in a clear, orderly, and compact fashion. Wentworth's College Algebra (Ginn & Co., Boston), Chaps. X. and XI.; Todhunter's Algebra (Macmillan & Co., New York), Chaps. VI.-VIII., XIII., XVIII., XIX., XXI.-XXIV., inclusive; and Wentworth and Hill's Exercise and Examination Manuals (Ginn & Co.) contain good examples for practice.

In geometry, the student should guard against committing his demonstrations and solutions to memory from his text-book. He should, so far as possible, work them out for himself, with his own diagrams, using the book as a guide, and always bearing in mind that his object is to learn a subject, not a particular author's presentation of that subject. He should make his diagrams as different from those drawn in his book as the conditions of the question allow; he should often use different lettering from the book; and sometimes try to invent proofs and solutions of his own, remembering always that the shortest and simplest methods, if rigorous, are best. This way of working will help him towards the solution of original problems, on which he should carefully prepare himself. It is an excellent practice to perform many actual constructions with the rule and compasses, according to geometric principles, and with the utmost care and finish. The student thus becomes familiar with the conditions of the possibility of a construction and with the actual use of theorems; and acquires a greater interest in his study. But he should remember that a fine drawing, however useful in its own way, has no geometric value; it is unnecessary to a sound demonstration and is powerless to redeem a faulty one.

One third of one full year of work may be taken to represent the time devoted to the study of elementary algebra at good schools; and one fifth of a year, the time devoted to plane geometry. A capable and somewhat mature student may prepare himself satisfactorily for the examinations in decidedly less time; but, on the other hand, the student who can give more study to plane geometry especially is strongly advised to do so. A thorough mastery of either of these subjects, on which all higher study of mathematics depends, and which contribute indirectly in an important degree to a vigorous mental training, necessarily requires time for the assimilation of the new conceptions and processes which characterize them, and for the formation of habits of exact thought.

3. (*Advanced*) *Mathematics.* — (*a*) Logarithms; Plane Trigonometry, with its applications to Surveying and Navigation.

4. *Physical Science.* — Either (1) Astronomy (The first eleven chapters of Young's Elements of Astronomy (Boston: Ginn & Co.),* and Physics (Avery's Elements of Natural Philosophy † or Gage's Elements of Physics); or (2) A course of experiments in mechanics, sound, light, heat, and electricity; these experiments must be not less than forty in number, and must be actually performed at school by the pupil; they may be selected from A. M. Worthington's Physical Laboratory Practice (Rivingtons, London, 1886), or from the "New Physics," by John Trowbridge (Appleton & Co., New York), or from any similar laboratory manual.

Previous to 1886 the only requirement in physics for admission to Harvard College and the Lawrence Scientific School was text-book work. In that year and the year following a pamphlet was prepared by the College describing in detail a laboratory course intended as an alternative for the text-book course. A candidate for admission may, therefore, now offer either a text-book course or a laboratory course. The laboratory course is strongly recommended to all who have the requisite opportunities, and a majority of the candidates examined for admission to the College now offer it. The considerations in favor of this course apply with even greater weight to those entering the Lawrence Scientific School than to those entering the College.

---

* In 1893 only, Lockyer's Elementary Lessons in Astronomy will be accepted as a substitute for the first eleven chapters of Young's Elements of Astronomy.

† The following portions of the 1885 edition may be omitted: — sections I. and II. of chap. I. (excepting arts. 23–30), arts. 254–267, 346–349, 371, 411–415, 445–455, 464–467, 470–476, 707–714, 729–745, and the whole Appendix.

The text-book alternative is retained because the teaching of physics by laboratory methods has not yet become general in the schools of the country at large. This requirement, if fully and thoroughly met, probably imposes as much work upon the student as the laboratory alternative.

Inquiry had shown that in a considerable number of the best schools which fit for Harvard College and the Lawrence Scientific School about five school-hours per week, presumably with some hours each week out of school, for one year were devoted to physics. Accordingly, the laboratory course described in the pamphlet was planned to occupy the student, in school and out, about seven or eight hours per week for one year.

As physics is no longer a required study in college, it was borne in mind, in planning the laboratory course for the schools, that very many of those taking it would never have any other systematic course in physics. Accordingly the exercises were so chosen as to cover a wide range of subjects and to have many applications in the experience of every-day life. The course at its last revision, in 1889, was arranged in forty-six exercises, any six of which may be omitted by the candidate. The examination for those who present this course consists of a written test upon questions closely connected with the work of the course, a laboratory examination, usually upon the exercises of the course, and an examination of the note-books used during the progress of the course in the schools. The written examination, though less important than the other two, and comparatively easy, gives valuable evidence as to the intelligence with which the student has carried on his work and the thoroughness with which he has mastered its principles.

Particular attention has been given to the question of pecuniary expense in the arrangement of the laboratory course, and with such success that the course is fully established in most of the schools that send many students to Harvard and is gradually making its way into smaller schools. The pamphlet describing this course is called a Descriptive List of Elementary Physical Experiments. It is for sale at the University Bookstore, Cambridge.

5. *English.* — This study may be offered at the Final Examination only. The candidate will be required to write a short composition on one of several subjects announced at the time of the examination. In 1893 the subjects will be drawn from one or more of the following works: Shakspere's Julius Cæsar and Twelfth Night, Scott's Marmion, Longfellow's Courtship of Miles Standish, the Sir Roger de Coverley Papers in the Spectator, Macaulay's second Essay on the Earl of Chatham, Emerson's American Scholar, Irving's Sketch Book, Scott's Ivanhoe, Dickens's David

Copperfield. Every candidate is expected to have read intelligently *all* the books prescribed.

The English written by a candidate in any of his examination-books may be regarded as part of his examination in English, in case the evidence afforded by the examination-book in English is insufficient.

The candidate will also be required to *correct specimens of bad English.*

The works prescribed for the examinations of 1894, 1895, and 1896, are the following: —

For 1894: Shakspere's Julius Cæsar and Merchant of Venice, Scott's Lady of the Lake, Arnold's Sohrab and Rustum, the Sir Roger de Coverley Papers in the Spectator, Macaulay's second Essay on the Earl of Chatham, Emerson's American Scholar, Irving's Sketch Book, Scott's Abbot, Dickens's David Copperfield.

For 1895: Shakspere's Merchant of Venice and Twelfth Night, Milton's L'Allegro, Il Penseroso, Comus, and Lycidas, Longfellow's Evangeline, the Sir Roger de Coverley Papers in the Spectator, Macaulay's Essays on Milton and Addison, Webster's first Bunker Hill Oration, Irving's Sketch Book, Scott's Abbot.

For 1896: Shakspere's Merchant of Venice and Midsummer's Night's Dream, Milton's L'Allegro, Il Penseroso, Comus and Lycidas, Longfellow's Evangeline, Macaulay's Essay on Milton, Webster's first Bunker Hill Oration, De Foe's History of the Plague in London, Irving's Tales of a Traveller, Scott's Woodstock, George Eliot's Silas Marner.

The first part of the examination in English is based upon selected works of standard English authors. The list of books changes from year to year, the announcement of the changes being published several years in advance. The student should read the prescribed books as he reads other books; he will be expected, not to know them minutely, but to have freshly in mind their most important parts. He may be asked to write an outline of a specified novel or to explain the purport of an essay.

Whatever the subject of the composition, the examiner will regard knowledge of the book as far less important than ability to write English. The student should therefore have constant practice in writing, and should test his work severely. He should spell correctly and punctuate intelligently. He should make sure — so far as he can — that every word means something, and the right thing; that every sentence is grammatical; and that thought follows thought in logical order. He should do his best to make his work accurate in every part, and to combine the parts in a coherent whole.

The student may train himself for the correction of specimens of bad English — the second part of the examination — (*a*) by correcting his own work; (*b*) by correcting the specimens of bad English in some elementary text-book.

In preparation for both parts of the examination, he should study the elements of grammar and rhetoric; and should apply what he learns (*a*) to his own writing; (*b*) to specimen pages of the prescribed books.

6 or 7. *German* or *French.** — The translation at sight either of simple German prose, or of ordinary French prose. The passages set for translation will be similar to those set at the final examinations in German *A* and French *A* respectively, — College courses each having three hours of instruction a week through the year. A knowledge of the language itself, rather than of the grammar, is expected; but proficiency in elementary grammar, or facility in writing the language, will be accepted as an offset for some deficiency in translation. It is recommended that from the outset attention be given to pronunciation.

A student who wishes to fit himself to pass the elementary examination in German for admission to the Scientific School should first master so much of the grammar as is contained in Sheldon's "Short Grammar." He is advised to give especial attention from the beginning to the rules for pronunciation. The study of the Grammar should be accompanied by the careful reading of at least two hundred duodicimo pages of easy German; such as Grimm's Fairy Tales, or the easier stories of Heyse, Storm, and Zschokke. There are several German readers which have good selections for beginners. Among others may be mentioned: Grauert's Reader (E. Steiger, New York), Joynes' Reader (D. C. Heath & Co., Boston), Whitney's Reader (Henry Holt & Co., New York). The student is advised to give himself a good deal of practice in reading "at sight"; that is to say, as soon as he has mastered a small vocabulary he should try to make out, without too constant use of the dictionary, the meaning of easy sentences which are new to him. A good book for practice in reading at sight is Leander's Träumereien (D. C. Heath & Co., Boston).

The one point in grammatical study which will best help the student to read at sight is a thorough mastery of all the irregular (or "strong") verbs.

To prepare for the elementary examinations in French, the student should use such books as Chardenal's first and second French courses and (in case he is working without the aid of a competent teacher) the keys to the exercises of the same. A student working without a teacher should write the exercises, then correct them with the help of the key, and write them over again a few days later without looking at the first draft. Not less than five hundred pages of French should be read. The best books to begin with are readers, such as Bôcher's French Reader, or Macmillan's Second Progressive French Reader; then easy novels and plays, such as l'Abbé Constantin, by Ludovic Halévy; la Poudre aux Yeux, and le Voyage de M. Perrichon, by Labiche. Excellent, as well as easy, historical reading will be provided by the Charles XII. of Voltaire. It is essential that some idea of the pronunciation should be obtained from some one fairly conversant with the French language. Gose's French-English and English-French Dictionary will be found at least as convenient as any.

FOR THE COURSE IN CIVIL AND TOPOGRAPHICAL ENGINEERING. — In addition to the above requisitions, candidates who propose to take this course will be examined in —

8. (*Advanced*) *Mathematics.* — (*b*) Either Solid Geometry or the Elements of Analytic Geometry.

All these subjects are identical with those in the Requirements for Admission to Harvard College.

DIVISION OF THE EXAMINATION.

Candidates for admission may be examined in all the subjects at a single examination in June or September; or they may be examined in part of the subjects in June of one year, and in the remaining subjects in the June or September of the following year; or the examination may be divided between the June and September examinations of the same year; but, in case the examination is divided, the student must at the first examination pass in at least two of the subjects, or his work at this examination will not be counted to his credit.

ADMISSION TO ADVANCED STANDING.

A candidate may be admitted to advanced standing either by passing examinations in all the studies already pursued by the class for which he offers himself, in addition to the entrance examinations; or from another scientific school or college upon such conditions as the Faculty may deem equitable in each case, regard being had to the applicant's previous course of study, and to the evidence of proficiency exhibited by him.

* Candidates from countries in which English is not spoken may defer the entrance examination in French *or* German to the end of their first year of residence.

The successful study of any subject in Harvard College will be taken as an equivalent for the same subject in the Scientific School; but no graduate of the College will be given a Scientific School degree without at least one full year's work in the School.

ADMISSION WITHOUT EXAMINATION. SPECIAL STUDENTS.

The courses of study in the Scientific School are open to persons who satisfy the Faculty of their fitness to pursue the particular courses they elect, although they have not passed the usual examinations for admission. These students are known as Special Scientific Students; they are members of the School from the time of their admission, but until regularly admitted are not candidates for the degrees given by the School.

Special Students are subject to all the regulations of the School. A report of their work is sent to their parents or guardians twice a year.

The Faculty reserves the right to deprive any Special Student of his privileges at any time, if he abuse or fail to use them.

A certificate of proficiency will be given, if desired, to any Special Student who has faithfully pursued his chosen subjects throughout a year and attained a grade not lower than Grade *B* therein.

Persons who propose to enter the School as Special Students are required to furnish testimonals of good moral character and to indicate the courses of study they wish to pursue.

TIMES AND PLACES OF EXAMINATIONS.

All examinations are held at the same times and places, and under the same conditions, as those for admission to College.

Candidates for admission to the Lawrence Scientific School will fill out the same blanks as other candidates, but must be careful to put upon each paper L. S. S. (abbreviation for Lawrence Scientific School).

Two regular examinations for admission are held each year, — one at the beginning of the summer vacation, and the other at the beginning of the academic year in the autumn.

First Examination.

In 1893, the *first examination* will be held on Tuesday, Thursday, Friday, and Saturday, June 27, 29, 30, and July 1, in the following places: In *Cambridge*, in Sever Hall; in *Quincy*, in the rooms of the Adams Academy; in *Andover*, in the rooms of the Phillips Academy; in *Groton*, in the rooms of the Groton School; in *Southborough*, in the rooms of St. Mark's School; in *Worcester*, in Curtis Hall, the Young Men's Christian Association building, Elm Street; in *Exeter*, *N. H.*, in the rooms of Phillips Exeter Academy; in *Concord, N. H.*, in the rooms of St. Paul's School; in *New York, N. Y.*, in the lecture-room of the Young Men's Christian Association, Twenty-third Street, corner of Fourth Avenue; in *Albany, N. Y.*, in the rooms of the Young Men's Christian Association; in *Buffalo, N. Y.*, in the High School building, corner of Court and Franklin Streets; in *Philadelphia*, in the rooms of the Young Men's Christian Association building, corner Fifteenth and Chestnut Streets; in *Washington, D. C.;* in *Cleveland, O.*, in the Central High School building; in *Cincinnati, O.*, in the rooms of the Law School, College Building, Walnut Street; in *Chicago, Ill.*, in rooms of the Chicago Athenæum, Van-Buren Street; in *St. Louis, Mo.*, in the Central High School building, corner of Olive and Fifteenth Streets; in *Minneapolis, Minn.*, in the Lecture-room of the Public Library building; in *Denver, Col.*, in the rooms of the Denver High School (District No. 1), corner of Nineteenth and Stout Streets; in *San Francisco, Cal.*, in the rooms of the Mechanics' Institute, 31 Post St.; in *Portland, Oregon;* in Bonn, Germany, at the Hotel Kley; and in *Tokyo, Japan.*

The university will ordinarily conduct the admission examinations in June in any school or city where the number of candidates for examination, preliminary or final, shall be not less than ten; provided that the school or city be not within easy reach of one of the regular places of examination. Applications for examinations in June, in schools or cities not named above, should be made to the Secretary of Harvard University as early as the 1st of April.

Candidates who wish to take the examinations in the advanced studies numbered 7 (*b*), 8, or 9, or in Analytic Geometry, must assemble punctually at 8.30 o'clock A.M. on the *first* day of the examination (Tuesday, June 27); all other candidates must present themselves at 8 o'clock A.M. on the *second* day of the examination (Thursday, June 29).

Candidates who wish to be examined in any place other than Cambridge, are required to give notice to the Secretary. The notice must *be in the Secretary's hands* not later than June 10. Candidates who intend to take any of the examinations of the first day must mention this intention in the notice.

A fee of five dollars must be paid in advance by every candidate who is examined at any place other than Cambridge. The whole fee of a candidate who purposes to divide his examination between two years is payable before his first examination: it should be sent by check, post-office order, or registered letter to CHARLES F. MASON, *Bursar*, Cambridge, Mass., and should be in the Bursar's hands not later than June 10.

Persons who do not intend to enter the School will be admitted to the examinations at other places than Cambridge on payment of a fee of five dollars; and, if successful, will receive certificates to that effect.

Second Examination.

The *second examination* will be held *in Cambridge only*, on Thursday, Friday, Saturday, and Monday, September 21, 22, 23, and 25.

All candidates must present themselves punctually at 8 A.M. on the *first* day of the examination (Thursday, Sept. 21).

ORDER OF EXAMINATIONS.

Tuesday, June 27, and Monday, Sept. 25.	Friday, June 30, and Friday, Sept. 22.	Saturday, July 1, and Saturday, Sept. 23.
	8–9, Elem. Physics.	10½–11½, Log. and Trigonometry.
	9–10, Plane Geometry.	11½–12½, Solid Geometry.
12½–1½, Analytic Geometry.	10½–11½, Algebra.	1½–2½, Elemen. French (French *A*).
	11½–12½, History.	2½–3½, Elemen. German (German *A*).
	1–2½, English.	

The stated time for the laboratory examination in Elementary Experimental Physics is Thursday, Friday, and Saturday of the examination periods; in Advanced Physics and Chemistry, Tuesday of the June period and Monday of the September period. These examinations are on these days held in Cambridge only, and appointments for them will be made when the candidates meet the officer in charge of the examinations.

In June, classes from schools in the vicinity of Cambridge may by special arrangement take the laboratory examinations in Physics and Chemistry on other days.

Laboratory examinations in Physics and Chemistry, but only for those who have previously passed the written examination and received a provisional mark, will be held as follows: Elementary and Advanced Physics on Wednesday, September 27, at 2 P.M. in the Jefferson Physical Laboratory, but these examinations may, if desired, be taken at the stated times as given above; Advanced Chemistry on Thursday, September 28, at 2 P.M. in Boylston Hall.

COURSES OF STUDY.

These courses are selected from the Courses of Instruction provided by the Faculty of Arts and Sciences, and are described at length on pages 61–111, under the heading which is given in the brackets.

Course of Four Years in Civil and Topographical Engineering.

Students, whose previous work enables them to pass the examinations in any of the required courses, may on so doing substitute for these courses others, chosen with the approval of the Faculty.

First Year.[*]

Analytic Geometry (Mathematics *B*). Professor C. J. White.

Mechanical Drawing. — Descriptive Geometry (Engineering 1). Messrs. Wait and Giblin.

Land Surveying (Engineering 2). Messrs. Wait and Giblin.

Elementary German (German *A*). Assistant Professor Schilling, Mr. Nichols, Dr. Poll. Dr. Bierwirth, and Mr. Coar.

Required of students who did not offer German at their examination for admission. Or

Elementary French (French *A*). Dr. Marcou, and Mr. Henckels.

Required of students who did not offer French at their examination for admission.

Also, *one* of the following courses: —

General Descriptive Chemistry (Chemistry 1). Professor Jackson.

Experimental Physics (Physics *C*). Messrs. Sabine and Hormell,

Lectures and Field Exercises in Geology (Geology 4 and 5). Professor Shaler, Dr. Harris, and Messrs. Ladd, Dodge, and Griswold.

Determinative Mineralogy (Chemistry 2). Dr. Huntington.

Second Year.

Spherical Trigonometry (Mathematics 1). Professor C. J. White.[*]

Differential and Integral Calculus (Mathematics 2). Professor C. J. White.[*]

Stereotomy and Machine Drawing (Engineering 8^1). Messrs. Wait and Giblin.

Construction and Maintenance of Common Roads (Engineering 3^2). Mr. McClintock.

Railroad Surveying, Location, and Construction (Engineering 4). Mr. Wait.

Translation, Reading at Sight, and Composition of German (German 1*a*, 1*b*, 1*c*, or *C*). Associate Professor Bartlett, Asst. Professor Von Jagemann, Dr. Robinson, Dr. Bierwirth, and Mr. Nichols.

Third Year.

Rational Mechanics, Graphical Statics, and Resistance of Materials. (Engineering 5). Professor Burr and Mr. Wait. Or

Elementary Mechanics (Mathematics 4). Dr. Osgood.

---

[*] Students of this School are advised to take Engineering *A* instead of the Analytic Geometry, Trigonometry and Calculus prescribed in these courses in Civil and Electrical Engineering and the course in General Science.

Hydraulics, Water Supply, and Sanitary Engineering (Engineering 7^1 and 7^2). Professor **Burr** and Mr. **Rice**.

French Grammar, Reading, Conversation, and Composition (French 1*a* or 1*b*). Asst. Professor **De Sumichrast**, Asst. Professor **Sanderson**, Dr. **Marcou**, and Messrs. **Henckels** and **Brun**.

Also, *one* of the following courses that has not already been taken: —

Experimental Physics (Physics *C*). Messrs. **Sabine** and **Hormell**.

General Descriptive Chemistry (Chemistry 1). Professor **Jackson**.

Determinative Mineralogy (Chemistry 2). Dr. **Huntington**.

Lectures and Field Exercises in Geology (Geology 4 and 5). Professor **Shaler**, Dr. **Harris**, and Messrs. **Ladd**, **Dodge** and **Griswold**.

Second course in Geology (Geology 8). Professor **Shaler**, Asst. Professor **Wolff**, and Mr. **Woodworth**.

Geology 8 is open only to those who have already taken Geology 4.

Constitutional and Political History of the United States (History 13). Asst. Professor **Hart**.

Fourth Year.

General theory of Machines, Water and Wind Wheels, and Steam Engines (Engineering 6). Professor **Burr** and Asst. Professor **Hall**.

Bridges, Structures and Foundations (Engineering 8). Professor **Burr** and Mr. **Giblin**.

Preparation of Thesis.

Also, *one* of the following courses that has not already been taken: —

Physical Geography and Meteorology (Geology 1 and 2). Professor **Davis** and Mr. **Ward**.

Elementary Zoölogy (Zoölogy 1). Professor **Mark**.

Elementary Botany (Botany 1). Professor **Goodale** and Mr. **Ganong**.

Lectures and Field Exercises in Geology (Geology 4 and 5). Professor **Shaler**, Dr. **Harris**, and Messrs. **Ladd**, **Dodge**, and **Griswold**.

Geological Field-work (Geology 22). Professors **Shaler** and **Davis**, Asst. Professor **Wolff**, and Dr. **Harris**.

Descriptive Chemistry (Chemistry 1). Professor **Jackson**.

Determinative Mineralogy (Chemistry 2). Dr. **Huntington**.

Qualitative Analysis (Chemistry 3). Professor H. B. **Hill**.

Introduction to Philosophy (Philosophy 1). Professors **Palmer** and **Royce**, and Dr. **Santayana**.

European History (History 1). Asst. Professor CHANNING.

Constitutional and Political History of the United States (History 13). Asst. Professor HART.

Principles of Political Economy (Economics 1). Professors TAUSSIG and ASHLEY and Messrs. CUMMINGS and COLE.

English Composition (English 12). Asst. Professor WENDELL and Mr. McCULLOCH.

German Literature (German 2, 3, or 4). Asst. Professor FRANCKE, Asst. Professor SCHILLING, and Dr. POLL.

French Translation and Reading at sight (French 2). Asst. Professor SANDERSON.

Students who complete this course, pass the required examinations, and present a satisfactory thesis, receive the degree of Bachelor of Science in Civil Engineering.

II. Course of Four Years in Chemistry.

This course is intended for students preparing to become practical chemists or teachers of the science.

Candidates who propose to take this course must offer at their examination for admission Experimental Physics and Chemistry.

FIRST YEAR.

General Descriptive Chemistry (Chemistry 1). Professor JACKSON.

Mineralogy (Chemistry 2). Dr. HUNTINGTON.

General Descriptive Physics (Physics 1). Asst. Professor HALL. Or

Experimental Physics (Physics *C*). Messrs. SABINE and HORMELL.

Elementary German (German *A*). Asst. Professor SCHILLING, Mr. NICHOLS, Drs. POLL and BIERWIRTH, and Mr. COAR.

Required of students who did not offer German at their examination for admission. Or

Elementary French (French *A*). Dr. MARCOU and Mr. HENCKELS.

Required of students who did not offer French at their examination for admission.

Rhetoric and English Composition (English *A*). Professors A. S. HILL and BRIGGS, and Messrs. HURLBUT, FLETCHER, COPELAND, and LAMONT.

SECOND YEAR.

Qualitative Analysis (Chemistry 3). Professor H. B. HILL.

Quantitative Analysis (Chemistry 4). Professor COOKE and Dr. RICHARDS.

German Prose (German 1*c*). Dr. ROBINSON.

Analytic Geometry (Mathematics *B*). Professor C. J. WHITE.*

Mechanical Drawing (Engineering 1, first half-year). Messrs. WAIT and GIBLIN.

THIRD YEAR.

Chemical Philosophy (Chemistry 8). Professor COOKE.

Quantitative Analysis (Chemistry 4*a*). Dr. RICHARDS.

The Carbon Compounds (Chemistry 5). Professor H. B. HILL.

Elementary Botany (Botany 1). Professor GOODALE and Mr. GANONG.

Elementary Zoölogy (Zoölogy 1). Professor MARK.

French Prose (French 1*b*). Asst. Professor SANDERSON.

FOURTH YEAR.

Advanced Problems in Inorganic Chemistry (Chemistry 6). Professor COOKE.

Advanced study and research with preparation of a thesis (Chemistry 20).

Students who complete this course, pass the required examination and present a satisfactory thesis, will receive the degree of Bachelor of Science.

III. Course of Four Years in Geology.

This course is designed to furnish a special training for those who wish to prepare themselves for duty in Government Geological Surveys or for teaching, or for those who desire to obtain the foundations of a training in Mining Engineering. The course may (on special application to the Faculty) be varied to meet the wants of individual students beyond the limits indicated in the programme. Those who make good use of the opportunities afforded by the Summer Schools,† held under the direction to the professors in the department, may shorten the course of study to three years. All students are required to take one of the advanced courses in Geology during one of their summer vacations. Students who design entering the School in the autumn of any year are advised to take the summer course in Elementary Geology, which is regarded as the equivalent of Geology 4 and 5.

FIRST YEAR.

General Elementary Geology Lectures (Geology 4). Professor SHALER and Messrs. DODGE and GRISWOLD.

---

* See foot-note on p. 24.

† Summer Schools, replacing the work in the following named College electives, will be given in 1893: Geology 4, 5, and 22, Physics *C*, Engineering 2 and 4, and German *A*.

General Elementary Geology Laboratory Work (Geology 5). Dr. HARRIS and Mr. LADD.

General Descriptive Physics (Physics 1). Asst. Professor HALL.

Determinative Mineralogy (Chemistry 2). Dr. HUNTINGTON.

Elementary French (French *A*). Dr. MARCOU and Mr. HENCKELS.

Elementary German (German *A*). Asst. Professor SCHILLING, Mr. NICHOLS, Dr. POLL, Dr. BIERWIRTH, and Mr. COAR.

Rhetoric and English Composition. Professors A. S. HILL and BRIGGS, and Messrs. HURLBUT, FLETCHER, COPELARD, and LAMONT.

SECOND YEAR.

Meteorology (Geology 1). Professor DAVIS and Mr. WARD.

Physical Geography (Geology 2). Professor DAVIS and Mr. WARD.

Elementary Zoölogy (Zoölogy 1). Professor MARK.

Elementary Botany (Botany 1). Professor GOODALE and Mr. GANONG.

Second Course in Geology (Geology 8). Professor SHALER. Asst. Professor WOLFF, and Mr. WOODWORTH.

General Descriptive Chemistry (Chemistry 1). Professor JACKSON.

German Prose (German 1*b*). Mr. NICHOLS and Dr. BIERWIRTH.

Twelve Themes. — Lectures and discussion of themes (English *B*). Asst. Professor WENDELL and Messrs. FLETCHER, CAREY, GARDINER, LAMONT, and HURLBUT.

THIRD YEAR.

Geological field work (Geology 22). Professors SHALER and DAVIS, Asst. Professor WOLFF and Dr. HARRIS.

Petrography (Geology 12). Asst. Professor WOLFF.

Palaeontology (Geology 14). Professor SHALER and Dr. JACKSON.

Mechanical Drawing (Engineering 1). Messrs. WAIT and GIBLIN.

Surveying, Plotting, and Topographical Drawing (Engineering 2). Messrs. WAIT and GIBLIN.

Forensics. — Lectures on Argumentative Composition (English *C*). Messrs. BAKER, CAFFEY, and HAPGOOD.

FOURTH YEAR.

Historical Geology (Geology 15). Professor SHALER and Dr. JACKSON.

Mineral Veins and Metalliferous Deposits (Geology 25). Professor WHITNEY.

And *one* of the following courses: —

Geological field work (second course) (Geology 22). Professors SHALER and DAVIS, Asst. Professor WOLFF, and Dr. HARRIS.

Physical Geography and (second course) (Geology 20). Professor DAVIS.

Petrography (second course) (Geology 23). Asst. Professor WOLFF.

A thesis embodying the results of field and laboratory work.

Professors SHALER and DAVIS and Asst. Professor WOLFF, will oversee and direct the work, in the field or library, of advanced special students in Geology.

Students who complete the above course and pass the required examinations will receive the degree of Bachelor of Science.

IV. Course of Four Years in Biology.

FIRST YEAR.

Physical Geography and Meteorology (Geology 1 and 2). Professor DAVIS and Mr. WARD.

Elementary Zoölogy (Zoölogy 1). Professor MARK.

Elementary Botany (Botany 1). Professor GOODALE and Mr. GANONG.

Lectures on Geology (Geology 4). Professor SHALER, and Messrs. DODGE and GRISWOLD.

Experimental Physics (Physics *C*). Messrs. SABINE and HORMELL.

Freehand Drawing and Painting in Water-colors (Fine Arts 1). Asst. Professor MOORE.

Elementary German (German *A* or *B*). Asst. Professor SCHILLING, Mr. NICHOLS, Dr. POLL, Dr. BIERWRITH, and Mr. COAR.

Required of students who did not offer German at their examination for admission. Or

Elementary French (French *A*). Dr. MARCOU and Mr. HENCKELS.

Required of students who did not offer French at their examination for admission.

SECOND YEAR.

General Descriptive Chemistry (Chemistry 1). Professor JACKSON.

Morphology of Plants (Botany 2). Asst. Professor THAXTER.

Morphology of Animals (Zoölogy 2). Dr. DAVENPORT.

Advanced French (French 1*a* or 1*b*). Asst. Professor DE SUMICHRAST, Dr. MARCOU, and Mr. HENCKELS, or Asst. Professor SANDERSON.

Advanced German (German *C*, 1*a*, 1*b* or 1*c*). Assoc. Professor BARTLETT, Asst. Professors SCHILLING and VON JAGEMANN, Mr. NICHOLS, and Drs. BIERWIRTH and ROBINSON.

Botany (second course) (Botany 3). Professor GOODALE and Mr. GANONG.

THIRD YEAR.

Comparative Anatomy of Vertebrates (Zoölogy 3). Dr. DAVENPORT.

Microscopic Anatomy (Zoölogy 4). Professor MARK and Dr. WOODWORTH.

Cryptogamic Botany (Botany 4). Asst. Professor THAXTER.

Qualitative Analysis (Chemistry 3) Professor H. B. HILL.

General Introduction to Philosophy (Philosophy 1). Professors PALMER and ROYCE, and Dr. SANTAYANA.

FOURTH YEAR.

In the fourth year the student is required to pursue some original investigation under the direction of one of the biological Instructors. At the end of the year he must present a thesis, giving the results of his studies. During the first week of the term he must arrange with his special Instructor the plan of study which he proposes, and this plan must be submitted to the Faculty of the Scientific School for their approval.

The courses in which research can be conducted are the following: —

Experimental Vegetable Physiology (Botany 20*a*). Professor GOODALE and Mr. GANONG.

Structure and Development of Cryptogams (Botany 20*b*). Professor FARLOW.

Anatomy and Development of Animals (Zoölogy 20*a*). Professor MARK.

[General Entomology (Zoölogy 20*b*). Professor HAGEN.]

So far as the time allows, collateral courses may be taken by fourth year students, and the following list may serve as a guide in the selection: —

English Composition (English 12). Asst. Professor WENDELL and Mr. McCULLOCH.

German Prose and Poetry. — Reading at sight and Composition (German 1*b*). Mr. NICHOLS and Dr. BIERWIRTH.

Translation and Reading at sight of French (French 8). Professor BÔCHER and Mr. BRUN.

Principles of Political Economy (Economics 1). Professors Taussig and Ashley, and Messrs. Cummings and Cole.

European History (History 1). Asst. Professor Channing.

History of the United States (History 13). Asst. Professor Hart.

Advanced Geology (Geology 8). Professor Shaler, Asst. Professor Wolff, and Mr. Woodworth.

Palaeontology (Geology 14). Professor Shaler and Dr. Jackson.

Comparative Osteology (Zoölogy 20*c*). Dr. Slade.

A more detailed account of these studies may be found in the Announcement of Courses of Instruction in Harvard College (see pp. 61–111).

Students who complete this course, pass the required examinations, and present a satisfactory thesis, will receive the degree of Bachelor of Science.

V. Course of Four Years in Electrical Engineering.*

The course in Electrical Engineering is so arranged that those persons who wish to acquire only a thorough acquaintance with electrical instruments and machines, with a view to working on electric lighting, power, transmission, etc., may find the studies best fitted for them in the first three years, by exchanging in the third year Mathematics 10 for Engineering 11. Students who in this way complete the studies of the first three years may receive certificates of that fact. Students who wish to study the higher theories of electricity will complete the four years course.

First Year.

Experimental Physics (Physics *C*). Messrs. Sabine and Hormell. Or

General Descriptive Physics (Physics 1). Asst. Professor Hall.

General Descriptive Chemistry (Chemistry 1). Professor Jackson.

Plane Trigonometry, Plane Analytic Geometry, and Calculus (Engineering *A*). *Double course.* Mr. Love.

Mechanical Drawing (Engineering 1). Messrs. Wait and Giblin.

Workshop (*once a week*). *Half course.*

Second Year.

Electrostatics, Electrokinematics, and Electromagnetism (Physics 3). Professor B. O. Peirce, Dr. Willson, and Mr. Kendrick.

Workshop (*once a week*). *Half course.*

---

* Candidates for the course in Electrical Engineering are strongly urged to offer the second alternative in Elementary Physics for admission.

Elementary German (German *A* or *B*). Asst. Professor SCHILLING, Mr. NICHOLS, Dr. POLL, Dr. BIERWIRTH, and Mr. COAR.

Required of students who did not offer German at their examination for admission. Or

Elementary French (French *A*). Dr. MARCOU and Mr. HENCKELS.

Required of students who did not offer French at their examination for admission.

Differential and Integral Calculus (second course) (Mathematics 5). Professor BYERLY.*

Rational Mechanics, Graphical Statics and Resistances of Material (Engineering 5). Professor BURR and Mr. WAIT.

Rhetoric and English Composition (English *A*). Professors A. S. HILL and BRIGGS and Messrs. HURLBUT, FLETCHER, COPELAND, and LAMONT.

THIRD YEAR.†

Electrodynamics, Magnetism, and Electromagnetism (Physics 4). Professor TROWBRIDGE.

Thermodynamics (Physics 6). *Half course.* Asst. Professor HALL.

The Steam-Engine (Physics 7). *Half course.* Asst. Professor HALL.

Dynamo Electric Machinery (Engineering 10). Mr. C. A. ADAMS.

Trigonometric Series. — Spherical Harmonics (Mathematics 10). Professors BYERLY and B. O. PEIRCE.

Practice in writing English. — Twelve Themes (English *B*). Asst. Professor WENDELL, and Messrs. FLETCHER, CAREY, GARDINER, LAMONT, and HURLBUT.

FOURTH YEAR.

Industrial Applications of Electricity (Engineering 11). Mr. ADAMS.

Mathematical Theory of Electrostatics and Electrokinematics (Physics 9). Professor B. O. PEIRCE.

Mathematical Theory of Electrodynamics and Electromagnetism (Physics 10). Asst. Professor HALL.

Thesis Work.

Students who complete the course of four years, and pass satisfactory examinations, will receive the degree of Bachelor of Science in Electrical Engineering.

---

* See foot-note on p. 24.

† Students who propose to take only three years of the Electrical Engineering course may substitute Engineering 11 for Mathematics 10 in the third year.

VI. General Course of Four Years in Science.

This course is intended for those who wish to lay a broad foundation for subsequent special work in science or who wish to prepare themselves for teaching. It prescribes elementary courses in Mathematics, Physics, Chemistry, Geology, Botany, and Zoölogy, and also affords the opportunity for more advanced work in one of these departments. At the beginning of the third year the student must select the department to which he wishes to give special attention, and the courses which he elects in the third and fourth years must have the approval of that department.

FIRST YEAR.

Rhetoric and English Composition (English *A*). Professors A. S. HILL and BRIGGS and Messrs. HURLBUT, FLETCHER, COPELAND, and LAMONT.

Elementary German (German *A*). Asst. Professor SCHILLING, Mr. NICHOLS, Dr. POLL, Dr. BIERWIRTH, and Mr. COAR.

Required of students who did not offer German at their examination for admission.

Elementary French (French *A*). Dr. MARCOU and Mr. HENCKELS.

Required of students who did not offer French at their examination for admission.

Analytic Geometry (Mathematics *C*). Dr. BÔCHER.†

Lectures and Field work in Geology (Geology 4 and 5). Professor SHALER, Dr. HARRIS, and Messrs. LADD, DODGE, and GRISWOLD.

Experimental Physics (Physics *B*). Asst. Professor HALL and Mr. HYDE. Or

Experimental Chemistry (Chemistry *B*),* Mr. TORREY.

SECOND YEAR.

Translation, Reading at Sight and Composition of German (German 1*a*, 1*b*, or 1*c*). Asst. Professor VON JAGEMANN, Messrs. NICHOLS and COAR, Drs. BIERWIRTH and ROBINSON.

Differential and Integral Calculus (Mathematics 2). Professor C. J. WHITE.

General Descriptive Chemistry (Chemistry 1). Professor JACKSON.

Experimental Physics (Physics *C*). Messrs. SABINE and HORMELL. Or

General Descriptive Physics (Physics 1). Asst. Professor HALL.

Freehand or Mechanical Drawing (Fine Arts 1 or Engineering 1). Asst. Professor MOORE, or Messrs. WAIT and GIBLIN.

---

* Candidates who propose to take this course must offer at their examination for admission either Experimental Physics or Chemistry.

† See foot-note on p. 24.

THIRD YEAR.

Translation, Reading at Sight and Composition of French (French 1*a* or 1*b*). Asst. Professor DE SUMICHRAST, Asst. Professor SANDERSON, Dr. MARCOU, and Messrs. HENCKELS and BRUN.

Qualitative Analysis (Chemistry 3). Professor H. B. HILL.

Elementary Zoölogy (Zoölogy 1). Professor MARK.

Elementary Botany (Botany 1). Professor GOODALE and Mr. GANONG.

Also two other courses chosen by the student with the approval of the department selected.

FOURTH YEAR.

In the fourth year the student will pursue a course of study which meets the approval of the department which he has already selected.

Students who complete this course and pass the required examinations will receive the degree of Bachelor of Science.

VII. Course in Anatomy, Physiology, and Physical Training.

This course is intended to afford a special training for those who wish to fit themselves to take charge of gymnasiums or to give instruction in physical exercises. It may advantageously be pursued by students who intend to study medicine or who need a systematic education of the body.

FIRST YEAR.

Experimental Physics (Physics *B* or *C*). Asst. Professor HALL and Mr. HYDE, or Messrs. SABINE and HORMEL.

Elementary Zoölogy (Zoölogy 1). Professor MARK.

Elementary Botany (Botany 1). Professor GOODALE and Mr. GANONG.

Personal Hygiene (half course). Dr. G. W. FITZ.

General Descriptive Chemistry (Chemistry 1). Professor JACKSON.

Rhetoric and English Composition (English *A*). Professors A. S. HILL and BRIGGS, and Messrs. HURLBUT, FLETCHER, COPELAND, and LAMONT.

Elementary French, or German (French or German *A*). Dr. MARCOU and Mr. HENCKELS, or Asst. Professor SCHILLING, Mr. NICHOLS, Drs. POLL and BIERWIRTH, and Mr. COAR.

Freehand Drawing (Fine Arts). Asst. Professor MOORE.

Gymnastics and Athletics. Dr. SARGENT and Mr. LATHROP.

Second Year.

Morphology of Plants (Botany 2). Asst. Professor Thaxter.

Morphology of Animals (Zoölogy 2). Dr. Davenport.

Comparative Anatomy of Vertebrates (Zoölogy 3). Dr. Davenport.

General Elementary Geology (Geol. 4 and 5) or Physical Geography and Meteorology (Geol. 1 and 2). Professor Shaler, Dr. Harris, Messrs. Ladd, Dodge, and Griswold, or Professor Davis and Mr. Ward.

Comparative Osteology (Zoölogy 10). Dr. Slade.

General Descriptive Physics (Physics 1). Asst. Professor Hall.

Qualitative Analysis (Chemistry 3). Professor H. B. Hill.

History of Physical Education (half course). Drs. Sargent and G. W. Fitz.

Twelve Themes, etc. (English *B*). Asst. Professor Wendell, and Messrs. Fletcher, Carey, Gardiner, Lamont, and Hurlbut.

Gymnastics and Athletics. Dr. Sargent and Mr. Lathrop.

Third Year.

(at the medical school).

General Anatomy and Dissection. Professor Dwight, Drs. Mixter, Conant, and Munro.

General Physiology. Professor Bowditch.

Histology. Professor C. S. Minot and Dr. Quincy.

Hygiene. Drs. Harrington and Durgin.

Foods and Cooking. Boston Cooking School.

Medical Chemistry. Professor Wood and Hills, and Drs. Worcester and Wentworth.

Auscultation and Percussion. Drs. Garland, Gannett, and Withington.

Gymnastics and Athletics. Dr. Sargent and Mr. Lathrop.

Fourth Year.

Psychology (Philosophy 2). Dr. Nichols.

Anthropometry (half course). Dr. Sargent.

Applied Anatomy and Animal Mechanics (half course). Dr. Sargent.

Physiology of Exercise (Experimental Physiology). Dr. G. W. Fitz.

Application of Exercise to Correction of Deformities (spinal curvature etc.) (half course). Dr. G. W. Fitz.

Forensics (English *C*). Messrs. Baker, Caffey, and Hapgood.

Gymnastics and Athletics. Dr. Sargent and Mr. Lathrop.

Practical exercises in general gymnastics and athletics will be given during the four years under the direction of Dr. Sargent, Mr. Lathrop, and other special instructors. Opportunities will also be afforded for teaching physical exercises, as soon as the pupils are prepared to give instruction.

Students in this course are also required to attend a summer course of six weeks in which they will receive instruction intended to supplement the courses required to be followed during term-time. Students are advised to offer for admission the Experimental Physics in place of the text-book alternative.

Students who complete this course and pass the required examinations will receive the degree of Bachelor of Science in Anatomy, Physiology, and Physical Training.

DEGREES.

The Degree of Bachelor of Science. — The degree of Bachelor of Science will be conferred upon any student who has fulfilled the above requirements in Civil Engineering, Chemistry, Geology, Biology, Electrical Engineering. The grades of the degree of Bachelor of Science are *cum laude*, *magna cum laude*, and *summa cum laude*.

The grade of the degree and the course of study for which the degree is given will be specified in the Diploma.

The requisitions for the degree of Doctor of Science, are stated on pp. 270, 271 of the University Catalogue.

REDUCTION OF THE COURSE TO THREE YEARS.

If a student has anticipated studies amounting to a substantial portion of the work of the first year, and desires to fulfil the requirements for the degree in three years, he may apply to the Faculty for leave so to do, specifying in his application the manner in which he proposes to arrange his studies for that purpose. The Faculty will decide on such applications according to the circumstances in each case.

Instruction in other Departments of the University.

All students of the Scientific School may, if found competent, pursue any of the courses of instruction given in the other departments of the University, except exercises carried on in the special laboratories, without additional charge, but this provision does not apply to Special Students unless they pay the full tuition fee of $150.

SCHOLARSHIPS.

Sixteen University Scholarships, of the annual value of one hundred and fifty dollars each, have been established in the Scientific School. Eight of these scholarships are assigned at the beginning of each academic year to meritorious students standing in need of such assistance, who have been in the School the whole of the preceding year, and propose to remain in it the whole of the ensuing year; and eight are available for students at the time of their entrance. The award is made by the Corporation on the recommendation of the Faculty. One third of the annual value of the Scholarships is paid at the time of the award, one third on January 12, and one third on April 12 following. Applications for these scholarships must be addressed, in writing, to the Dean, by the 1st of June.

There are also scholarships in the Scientific School, not exceeding eight at any one time, of the annual value of one hundred and fifty dollars each, for the benefit of graduates of reputable Normal Schools in the United States. The incumbents are originally appointed for one year on the recommendation of the principals of the schools from which they have been severally graduated; these appointments may be annually renewed on the recommendation of the Faculty.

FELLOWSHIPS.

Graduates of the Scientific School may be appointed to the Parker Fellowships, the John Thornton Kirkland Fellowship, the Morgan Fellowships, and the John Tyndall Scholarship.

Students in the Scientific School may also be appointed to the Kirkland Fellowship and Tyndall Scholarship, and, if graduates of Harvard College, to any of the above Fellowships or to the Harris Fellowship. For full information, see pp. 274–279 of the University Catalogue.

PRIZES.

Students in the Lawrence Scientific School may compete for the Bowdoin Prizes, for full information in regard to which see pp. 128–135 of the Catalogue of Harvard University.

FEES AND EXPENSES.

The tuition fee for the academic year in any of the above departments or courses is $150.

The tuition fees for candidates for the degree of Doctor of Science are stated on pp. 282–284.

The other expenses of a student for an academic year, clothing and washing not being included, may be estimated as follows: —

Room	$30	to	$100
Board for thirty-eight weeks	114	to	304
Books	20	to	25
Fuel and lights	15	to	35
Total	$179	to	$464

The tuition fee for a student taking a partial course is the same as in Harvard College (see pp. 217, 218 of the University Catalogue).

Students in the Scientific School may join the Harvard Dining Association, and board at cost at Memorial Hall. They may obtain rooms in the College buildings by applying to the Bursar, either by mail or in person; but all students living in College rooms are subject to the regulations of the Parietal Committee, in the same manner as undergraduates of Harvard College. See pp. 219–221 of the University Catalogue.

Students in Chemistry are supplied with all needed apparatus, but are required to restore it in as good condition as when received. They are charged for all damage or breakage, and also from ten to thirty dollars per annum for chemicals and use of apparatus.

Students in Engineering provide their own drawing materials.

The Hemenway Gymnasium, the Scientific School Library, and the College Library are open to members of this School without extra charge

The term-bills are issued December 22, March 22, and one week before Commencement, and are to be paid respectively on or before January 12, April 12, and October 10; but the third bills of candidates for degrees must be paid at least one day before Commencement. When a student severs his connection with the School his whole bill becomes payable at once.

A student who joins the Lawrence Scientific School after the beginning of the academic year will be charged for instruction from the beginning of the third in which he joins. One who leaves during the year will be charged for instruction only to the end of the third in which he leaves, if before that time he gives written notice of his withdrawal to the Dean; otherwise he will be charged for instruction to the end of the third in which such written notice is given. The first third begins at the beginning of the academic year and ends December 31. The second third begins January 1 and ends March 31. The last third begins April 1 and ends at Commencement.

BONDS.

Every student must file a bond with the Bursar in the sum of $200, signed by two bondsmen, one of whom must be a citizen of the United States, as security for the payment of dues to the University; or he may deposit with the Bursar $200 in money or in United States bonds for the same purpose; or he may deposit $50 as security, and pay his tuition-fees in advance as follows: one third on or before October 1, one third on or before January 1, and one third on or before April 1.

Every student who takes a College room or boards at Memorial Hall or at the Foxcroft Club must file a bond for $400 or make a deposit of $400, *or*, in addition to the requirements of the preceding paragraph, he may, if he occupies a College room, pay the full year's rent in advance, and, if he boards at Memorial Hall or at the Foxcroft Club, he may make a deposit as security for the payment of his board at the rate of $5 a week. Interest is not allowed on deposits.

No officer or student of the University will be accepted as bondsman.

For further information address Professor N. S. SHALER, Dean of the Lawrence Scientific School, Cambridge, Mass.

In the following Appendix will be found somewhat detailed descriptions of the work done in certain Departments of the Lawrence Scientific School.

DEPARTMENT OF ENGINEERING.

DESCRIPTION OF THE PRINCIPAL TECHNICAL COURSES IN THE DEPARTMENT OF ENGINEERING OF HARVARD UNIVERSITY.

1893–94.

GENERAL STATEMENT.

The Engineering courses have recently been reorganized, and established upon a technical basis sufficiently broad to meet the requirements of the most advanced engineering practice of the present time. Those courses which represent the essential portions of the professional occupations of civil, topographical, mechanical, and electrical engineers are required in the work of every student in the department. These essential subjects are supplemented by such elective courses as the future technical work of the student, or the natural trend of his capacities or talents may indicate as most useful for him. There is thus offered to young men who desire to attain an education in engineering not only the advanced technical training in the general and special field of engineering work, which gives them control of all branches of design, construction, and operation, but also instruction which aids in developing their executive capacity, and prepares them to originate and conduct, in the progress of their professional career, those engineering enterprises which play important parts in the development of the material resources of the country.

METHODS OF INSTRUCTION.

The method of instruction is that of lectures and conferences supplemented by demonstrations by the students in such portions of the various engineering subjects as are best adapted to that mode of treatment. Laboratory work with steam engines, testing machines, dynamos, motors, lathes, planers, and other machines is required at all available points in the courses of study. Field work with surveying and geodetical instruments is made a prominent feature in the course. The resulting notes and data are carefully worked up and preserved, and maps, plans, sections, etc. made from them precisely as in actual engineering operations. Frequent visits of inspection and observation are made to engineering works (including those of electrical engineering) in process of construction and operation, for which the vicinity provides unusual facilities.

COURSES OFFERED.

The courses in civil and topographical engineering, in mechanical engineering, and in electrical engineering, extend through four years, the first two of which are devoted mainly to a general cultivation in French and German, mathematics, geology, physics, chemistry, etc., land and railroad surveying. The last two years are more specially technical, although some of the general courses are carried throughout the four years either as required or elective studies.

A partial outline, although in some detail, of the purely technical subjects which are mentioned by title only in the University Catalogue, will be found below.

Civil Engineering.

LAND SURVEYING.

The course in topography will consist of practical instruction in topographical, land, and city surveying. Actual surveys will be made, notes plotted, areas calculated, and maps completed in ink and colors. Practice will be given in leveling, in the determination of grades, setting of grade stakes, contouring, and the computation of earthworks. The instruction is intended to make the student familiar with the methods and instruments employed in surveying, and to enable him to perform the operations of surveying, leveling, and plotting.

MECHANICAL DRAWING.

The course will include the use of draughting instruments; the stretching and mounting of paper; lettering; problems in geometrical drawing; descriptive geometry, including problems in projection of points, lines, planes, and single and double curved surfaces and in the tangencies, intersections, and development of the same; tinting in india ink and colors; shades and shadows, including the determination of brilliant lines and points, shade lines and shadows of plane and curved surfaces, and the shading of the same; isometric drawing, perspective, by the method of architects, from plans, and by the method of artists from the object.

The course will afford a training suitable for those intending to teach industrial drawing in public schools, and for students intending to pursue architecture or engineering, being nearly the same course as is usually given during the first year by schools of architecture and engineering.

The subjects of machine drawing and astronomy are given in the second year's work.

RAILROAD SURVEYING, LOCATION, CONSTRUCTION AND OPERATION.

Exploration. — Reconnaissance. — Preliminary surveys. — Final location. — Fixing grades. — Running in curves. — Setting slope stakes. — Estimating quantities. — Mapping. — Drawing specifications. — Awarding and executing contracts. — Drainage. — Ballasting and track laying. — Switches and signals. — Maintenance and operation of line.

The engineering students are made thoroughly familiar with the adjustment and use of instruments prior to the beginning of the course in railroad work. In addition to the lectures and other class-room work, the students go into the country, and locate and lay out complete a line of railway several miles in length. All curves are carefully run in, grades established with a view to economical operation and maintenance, slope stakes set, cuts and fills estimated, and specifications and forms of contract drawn to cover all labor and material for the finished road-bed. The best systems of keeping and preserving field notes are followed, and maps, profiles, and sections for the entire line are made from them. Every step and detail in the location and construction of the actual line of road surveyed is taken and followed, precisely as if it were to be constructed and made ready for traffic. The subject of signals, as well as the maintenance and operation of the line and the general economics of railroad management, receives as far as practicable the same kind of treatment.

RATIONAL MECHANICS AND GRAPHICAL STATICS.

Equilibrium. — Static moments. — Centres of gravity. — Force polygon. — Reciprocal figures. — Graphic methods in general. — Moments of inertia. — Direct stresses of tension and compression. — Shearing. — Bending or flexure. — Torsion. — Unbalanced forces and motions produced by them. — Work. — Energy. — Motions of liquids and gases.

The course in rational mechanics is given at the beginning of the third year, and forms the rational or mathematical basis of the technical or practical subjects which follow later in the engineering course of study.

It is so selected and arranged as to secure to the student thorough and advanced training in the theory of the technical portion of the engineer's practice, leaving for the later courses its full and detailed applications to the various branches of that practice. Thoroughness in theory in this course is combined with a constant attention to its application in practical work.

HYDRAULICS.

Flow of water through orifices, pipes, and canals. — Weirs. — Times required to discharge canal locks, etc. — Gauging of streams and pipes by use of current meter, piezometer, Venturi meter, etc. — Power of waterfalls. — Impact of water. — Resistance of medium. — Motion of fluids of varying density.

This course is devoted to the practical applications of the principles affecting the motions of liquids and gases, as established in the course in rational mechanics, and to those questions and problems in hydraulics and pneumatics encountered in the practice of the hydraulic engineer. As much instruction as possible is given in connection with hydraulic works in the field. The various methods of gauging the flow of streams are applied as in actual engineering practice at the numerous available points within easy reach of the University. Every student is required to take observations and make reports and estimates, and demonstrate practical familiarity with Kutter's and other formulae.

HYDRAULIC AND WIND MOTORS.

Overshot, undershot, and breast wheels. — Inward, outward, and downward flow turbines. — Establishment of turbine plants. — Water engines. — Wind wheels.

This course, logically following that in hydraulics, gives a practical treatment of hydraulic and wind motors, in which the relative value of the different forms of motors in the development of the power of waterfalls is clearly shown. The older forms, *i. e.* the overshot, undershot, and breast wheels, are treated with a view to the special conditions under which their use has been and is still advisable. All forms of turbines receive that careful attention which their great importance in mechanical industries demands. The conditions under which the greatest efficiencies are developed are carefully investigated, both analytically and by the results of tests of full-sized wheels. The study of wheel design is conducted by the aid of actual wheels of the best types and proportions. Especial attention is given to the establishment of turbine plants with a view to their economic and efficient operation, accessibility, &c.

MACHINES.

Elementary machines. — General theory of machines. — Kinematics of machinery. — Efficiency of machines. — Steam engines. — Pumping engines.

It is intended in this course so to give the general features of the theory of machines as generators and transmitters of power as to discover and fix the conditions under which their operation, to produce given results, is the most economical and efficient, and then to apply the principles thus established to the general treatment of some elementary machines as well as to the steam engine and pumping engine. The design, establishment, and operation of the two latter, with their necessary boilers and accessories, together with the methods of testing them, are made the subjects of careful and detailed treatment.

WATER SUPPLY AND SANITARY ENGINEERING.

Rainfall and storage of requisite supply for given population. — Methods of supply, gravitation, pumping, etc. — Settlement and filtration. — Conduits and mains. — House supply. — Wastage and checking of same by meters. — Waste water and sewage. — Treatment and disposal of sewage. — Mains and lateral sewers. — Catch-basins, overflows, etc.

The requisite treatment for the complete designs of city water supplies, both by gravitation and pumping (and incidentally by artesian wells), from the survey of the water-shed to the house service, is given in detail in this course in connection with the description of some of the best types of works. The effects of soils on the precipitated water, and the importance of the geological character of the water-shed, as well as the conditions affecting the plans of storage and determining the supply, are all considered. The pollution and filtration of potable waters, as well as the whole subject of sanitary engineering, including the best methods of treatment and disposal of sewage, are treated in the light of the latest experience. A design of a complete system of sewers for a city is included in the course.

RESISTANCE OF MATERIALS.

Materials of engineering in tension, compression, bending, shearing, and torsion. — Beams, girders, columns, shafting. — Testing of iron, steel, cements, brick, stone, etc. — Resistance of brick and stone piers. — Fatigue of metals. — Working stresses, specifications. — Resistance of iron and steel cables.

The course in the resistance of materials gives the student an exact and comprehensive knowledge of the nature of all the materials used in engineering constructions, as well as the laws of their behavior under stress, both above and below the elastic limit. Tc that end the theories of bending in continuous and non-continuous beams, torsion, long columns, etc., are accurately given, as well as the methods of applying them to the practice of the engineer by the aid of tests of full-size pieces or members, so as to make them of the greatest practical value. Students are required to make the various tests of iron and steel, cement, stone, etc., on the testing machines of the engineering department; and reduce the observations precisely as in actual practice. The various characteristics of materials under test are thus shown in a practical manner. The formulae constituting the foundation of the theory of drawbridges and other continuous bridges are developed in this course.

BRIDGES AND BUILDINGS.

The elementary truss. — Various forms of trussing. — Redundant members. — Greatest stresses in members by analytical and graphical methods. — Pin bridges. — Riveted bridges. — Multiple systems of bracing. — Roof trusses. — Crane trusses. — Suspension bridges. — Arched ribs. — Details of iron and steel construction. — Complete designs of railway bridges and other structures. — Erection of bridges and buildings.

Iron and steel have now entered so largely into building construction that the principles governing it must receive the same attention as those on which bridge construction is based. It is within the scope of this course, therefore, not only to include all those general and detailed considerations which lead to economic bridge design for the multiplicity of conditions under which the engineer must act, but, also, to establish the principles which underlie the proper design of the iron and steel work of buildings. The best forms of trusses for short and long spans, the judicious use of plate girders, riveted and pin bridges, cantilevers and stiffened suspension bridges are investigated and established. The test for the redundancy of truss members and the reasons for avoiding redundacy receive careful attention, as do, also, the relative merits of single and multiple systems of bracing. The treatment of arched ribs is not only complete in theory, but includes the discussion of the conditions under which they may properly be used. The course includes a very complete investigation of draw or swing bridges, together with their locking and turning machinery; it is closed by making complete designs of structures, which involve the rules governing correct details.

MASONRY AND TIMBER STRUCTURES AND FOUNDATIONS.

Earth pressure.— Retaining walls.— Reservoir walls.— Dams.— Arches. — Masonry bridge-piers. — Concrete. — Piling. — Docks. — Pneumatic work. — Open dredging for foundations. — Tunnels.

The theory of the pressure of earth as a granular mass of material without cohesion or adhesion, with the greatest surface slope dependent upon the friction of the grains upon each other only, is established and applied in the design and general treatment of retaining walls. Arches are considered subject not only to vertical loading but also to a combined vertical and horizontal or inclined pressure, as must be the case with earth loading. Particular attention is given to the determination of the proper outlines of high masonry dams by the latest and best methods. The subject of bridge piers and foundations is investigated, not only as to stability and economy in view of the great variety of conditions which may affect the design of this class of structures, but also as to effect on the proper length of spars when considered in connection with the superstructure. The special methods of the pneumatic and open dredging caissons for deep and difficult foundations are elaborated with all the fulness demanded by their importance. The use of piles in foundations and docks, with their driving and proper loading, are brought before the students in the most practical manner, and visits to such works in progress are made whenever feasible. This course includes both the usual methods of driving tunnels in rock and those by pilot and shield in dry earth or sand and in soft and wet materials.

HIGHWAY ENGINEERING.

This course is intended to afford a training in the construction and management of ordinary carriage roads. The instruction is given in connection with the courses above mentioned and will consist of lectures, conferences, laboratory and field work. The location and survey of roads are treated in reference to the conditions governing such work. The foundations and selection of materials, the treatment of the road metal in construction and the surface finish, for various classes of traffic receive careful attention. The various kinds of city pavements for heavy traffic are also considered. The costs and economic aspects of road problems occupy a portion of time commensurate with their importance. The students will be provided with opportunities for practical experience in the details of roadbuilding. The region in the vicinity of the School affords excellent examples of the various methods practised in constructing streets and other highways.

Mechanical Engineering.

The course in mechanical engineering is designed to afford students who pursue it a thorough professional preparation in those branches of engineering work which include the design, construction and operation of machines and machinery plants requisite for the development and transmission of power, and which lead to the management of enterprises formed for the purpose of adapting natural sources of power to industrial operations. To that end a thorough mathematical and physical basis of the science of energy in all its useful applications, is laid in the early part of the course, while the practical development of the problems in actual engineering operations is made at a later period. It is the aim of the machine shop practice not so much to gain manual craft as to acquire perfect familiarity with, and control of the principles which underlie efficient and economical machine design and shop management: the aim is thus to develop the capacity to execute the corresponding engineering operations in a manner consistent with the best engineering practice.

The subjects of rational mechanics and graphic statics, resistance of materials, hydraulics, hydraulic and wind moters are identical with those given in the course in civil engineering.

The subject of bridges and building is considerably curtailed, although it is made ample for the needs of mechanical engineers.

The subject of machines, on the other hand, is materially amplified, kinematics of machinery is treated in much detail, as well as the study and design of various valve gears.

Every student is required to make an extended series of engine and boiler tests, and become thoroughly familiar with the use of the indicator and indicator cards.

The subject of the efficiency of machines is also considerably elaborated, particularly in connection with the use of lubricants and anti-friction metals. The transmission of power by shafting, belts, and other mechanical devices receives careful attention, as well as the subject of hoisting and transferring machinery.

An extension of the subject of resistance of materials is made to cover the design of all parts of machines, such as shafts, pulleys, journal bearings, and teeth gearing.

THERMODYNAMICS AND STEAM ENGINEERING.

The Science of Thermodynamics.— The Mechanical Effects of the Expansion and Compression of Gases and Vapors under General and Special Conditions.— Work of Vapors and Gases in Adiabatic and Isothermal

Expansion. — Condensation of Steam and other Vapors. — Value of Fuels. — Calorimeter and Power Tests of Steam Engines and Boilers. — Transmission of Power by Compressed Air.

The subject of thermodynamics forms the basis of a thoroughly rational treatment of modern steam engineering, and is given with that special purpose in view. The establishment of the general principles of the science is supplemented by their applications in detail to the economic use of steam and air, or other gases, in the development of energy or its transmission. This involves a careful consideration of the work performed in adiabatic and isothermal expansion of vapors and gases, with the effects of jacketing cylinders and superheating.

The evaluation of solid, liquid, and gaseous fuels, and the devices requisite for their proper combustion receive close attention, as well as the theory and practice of calorimeter and power tests of engines and boilers. The use of compressed air in many operations of mechanical engineering, and for the transmission of power over long distances demands a careful study of those subjects, and ample provision is made for it.

MACHINE SHOP AND FOUNDRY PRACTICE.

Wood-working and Pattern-making. — Chipping, Filing, and Machine Tool Work. — Forging. — Lathe and Planer Work. — Moulding, Coreing, Ordinary and Chilled Castings. — Steel Castings.

The workshop equipment of the Lawrence Scientific School includes a new and efficient complement of woodworking machinery, together with lathes and planers, driven by electric moters, small forge shop, and complete set of corresponding machine and hand tools. The School also has at its service a steam engine and boiler fitted with all testing appliances. These facilities are also supplemented by the privileges of the entire equipment of the Rindge Manual Training School situated in close proximity to the University.

Students in this course, therefore, are afforded exceptional opportunities for attaining both theoretical and technical skill in those portions of a mechanical engineer's experience involving both machine shop and foundry practice.

The proper methods of designing castings so as to require the simplest patterns and attain the best results in the finished piece are applied to actual cases. The correct principles of moulding; the making and use of cores, and the production of ordinary chilled and steel castings are set forth in the same manner. Sufficient practice in the use of hand and machine tools, lathes, and planers is given to insure a complete control of all machine shop and foundry operations, as well as those of the forge.

Electrical Engineering.

The aim in designing the course in electrical engineering at the Lawrence Scientific School, has been to fit men to be primarily *engineers*, in the broad sense of the word, and then electrical engineers; in other words, to fit men to be electrical *engineers*, and not simply electricians. The importance of a general engineering education to a man in any one branch of engineering can hardly be overestimated. Especially is this true in the case of the electrical engineering.

Electrical energy, in large quantities, for commercial purposes, is produced almost entirely by means of steam or water power, so that it is essential for an electrical engineer to have a knowledge of steam and hydraulic engineering, as well as of the transmission and measurement of power.

Accordingly the greater part of the first three years of the course is occupied by studies which will give the student a broad foundation for the more specialized courses which are to follow, and for his future professional work.

The principal studies of the course are, physics, mathematics, and the subjects in general engineering, especially steam and hydraulic engineering. Besides these requirements are English, German, French, and a one year course in chemistry.

The study of physics begins in the first year and extends throughout the four years with a very large amount of laboratory work. In the first year it consists of general physics, and in the following years principally of electricity, theoretical and applied. The laboratory work gives the student a thorough acquaintance with electrical apparatus and with the best methods of electrical testing of all kinds.

The study of mathematics begins in the first year with higher algebra, analytical geometry, and descriptive geometry, and continues through the second and third years in calculus, differential and integral, differential equations, spherical harmonies, and trigonometric series. About one half of the time in the last year is devoted to the mathematical theory of electrostatics, electrokinematics, electrodynamics, and electromagnetism, the books principally used being Mascart & Joubert's "Treatise on Electricity and Magnetism," and Maxwell's "Treatise on Electricity and Magnetism."

In the third year the study of the applications of electricity begins to industrial purposes, such as electric lighting, transmission of power, etc. This part of the work consists of lectures and laboratory practice.

The Electrical Engineering Laboratory is equipped with the principal types of dynamos, electrical appliances and testing apparatus. It also has in connection a machine shop for the purpose of constructing special apparatus and any electrical machinery which the students may design.

By means of the lectures the student is kept in touch with the most recent advances in electrical science and the electrical industries.

The important electrical journals, English, French, German, and American, are always in the reading room of the L. S. S. Library, and the best articles are pointed out to the students.

In the Laboratory thorough tests are made on the various types of dynamo electric machinery, and the student becomes both theoretically and practically familiar with electrical machinery and appliances.

A part of the last year is devoted to some original research, upon which the student bases his graduating thesis.

During the course the students visit the best constructive engineering establishments in Boston and vicinity, and although their attention is expressly directed toward electrical engineering, they are required to note the advances in the other branches of engineering, especially those pertaining to the mechanical branch of this art.

THE CHEMICAL LABORATORY

AND

MINERALOGICAL MUSEUM.

The Chemical Department occupies the whole of Boylston Hall and also the mineralogical section of the University Museum.

Boylston Hall was erected in 1857 with a fund bequeathed by the late Ward Nicholas Boylston, which was subsequently largely increased by subscription. The hall was enlarged by the addition of a third story in 1870, and the accommodations were still further extended in 1891. Besides several private laboratories and preparation rooms, the building contains six large laboratories for students. A room on the upper story with one hundred desks is especially devoted to qualitative and descriptive work. On the lower story a laboratory with thirty-six places is wholly reserved for quantitative work, and connected with it is a weighing room, a furnace room, a machine shop, and a room of nearly constant temperature for gas analysis and thermo-chemistry. On the same story is a laboratory for organic work with twelve places, and with contiguous rooms for organic analysis, distillations, and similar processes. In addition there is a laboratory, also with twelve desks, especially fitted up for advanced work in inorganic chemistry; and further a large laboratory with sixty-four places for the most elementary class. On the third story is a large organic laboratory. On the second story are two large lecture-rooms, a reading-room, departmental library, and a chemical museum.

The mineralogical section of the University Museum was built in 1890–91 with a fund of about $50,000, raised wholly by subscription. To this building has been transferred the large and valuable mineralogical collection of the University, including an extensive collection of meteoric specimens, which is open to the public on week-days from 9 to 5 o'clock. In addition the new building contains a mineralogical laboratory provided with special collections for students' use, a mineralogical lecture-room, a laboratory for mineral analysis, and an advanced laboratory well furnished with all the requisites for work in determinative and optical crystallography.

All the courses of instruction in Chemistry to students of Harvard College, of the Lawrence Scientific School, and of the Graduate School, are given in Boylston Hall; all those in Mineralogy at the University Museum. The laboratories in both buildings are open to Special Students who desire to follow, under the instruction of the Director and his associates, any line of chemical or mineralogical investigation. The facilities for research are unusually great.

PROGRAMME OF COURSES.

Courses in Chemistry primarily for Undergraduates.

A. Elementary Chemistry (lectures). *Th., at 12 (first half-year).*

This course is intended to give a general conception of the aim and scope of chemical science. It deals solely with fundamental principles and such elementary facts as have an important bearing in the scheme of nature. It does not enter into details, although it seeks to make the student so far acquainted with chemical nomenclature and symbols as to make the chemical references in contemporary literature intelligible.

An examination on these lectures is held during the mid-year, which Freshmen are required to pass. This examination counts as one fifth of a course in the requirements for the degree of A.B. The lectures however are open to all members of the University, and no special registration is required for admission to them. But students who wish to have them counted toward a degree, or advanced standing, must register and pass the examination as in other courses. Students not in residence can prepare for the examination by studying "The New Chemistry" (D. Appleton & Co., publishers), and the same book is recommended as parallel reading to students attending the lectures.

B. Experimental Chemistry. — Lectures or recitations and laboratory work. *Tu., Th., 2.30–5.* Mr. Torrey.

Course *B* supplements Course *A*, and is designed for Freshmen and all those desiring to become familiar with the experimental evidence of the principles of Chemistry. It is not open to students who have passed in the Elective Chemistry at the examination for admission. Each exercise consists of a lecture or recitation followed by laboratory work. The latter will offer experimental demonstrations of the principles illustrated in the lectures of Chemistry *A* as well as in those of this course. This course is not special or technical, but is intended to give to the general student a clear conception of the methods, evidence, and logic of a purely experimental science. In all these respects an experimental science differs so widely from a literary or abstract enquiry, and chemistry has such an intimate relation to the arts of life, that it is important that the educated man should have a clear conception of its limitations as well as of its possibilities; and such a conception cannot be acquired without handling the tools.

Course *B* may be taken either as a full course or as a half-course. Students desiring only a limited training in the methods of experimental Chemistry should take it as a half-course. In that case the student will attend the Tuesday exercises only. As the accomodations are limited students who wish to take it as a full course must positively obtain the consent of the Instructor in advance. The full Course *B* corresponds to the Elective Chemistry of the examination for admission, and those preparing for that examination will be regarded as having the first claim to places in the laboratory as full course students.

The course followed in Chemistry *B* is laid out in full in the book entitled "Laboratory Practice: a Series of Chemical Experiments intended to Illustrate the General Principles of the Science," published by D. Appleton & Co., 1891. This book is an expansion of the "Descriptive List" first published by the University as fairly representing the elective requisition above referred to. The number of experiments has not been materially increased, but the methods have been improved, the descriptions have been made more full, and the attention directed to important inferences by means of questions and problems.

1. General Descriptive Chemistry, including its applications in the arts, and embracing the scheme of the chemical elements. — Lectures (*Mon., Fri., at 12*) and laboratory work (*Tu., Th., 1.30–3.30, or Wed., Fri., 2.30–4.30*). Professor JACKSON.

Course 1 should be preceded by Course *B*, but is open to Freshmen who have passed in the Elective Chemistry for admission or who satisfy the Instructor that they are fitted to pursue the course. This extended course of lectures on Descriptive Chemistry furnishes not only an essential prerequisite to the further study of the science, but also offers an important means of liberal culture. It supplements Courses *A* and *B*. The former deal chiefly with fundamental principles of Chemistry, and only a few of the more elementary facts are studied as illustrations of these principles. Chemistry 1, on the other hand, offers a systematic presentation of the accumulating facts of the science, and covers the whole ground of what is distinguished as inorganic chemistry. The accumulation is so great that only the most important facts can be studied in one of our college courses. Nevertheless, all the chemical elements, except the rarer and less authenticated, are passed in review and their relations discussed; and in connection with each element such compounds are described as have important applications in the arts of life. In a word, the course is intended to furnish that knowledge which is essential to the chemist and important to every man who is connected, however remotely, with chemical industries. To derive the greatest advantage from the course, the student should follow up faithfully a course of reading parallel to the lectures. The last edition of the Treatise on Chemistry by Roscoe and Schorlemmer (the organic part in three large 8vo volumes) is the fullest and best exposition of the subject in the English language; but the shorter work of Thorpe (two 12mo volumes) is also a trustworthy guide, although not so full or so valuable for reference. Other books valuable for certain details will be pointed out at the lectures.

3. Qualitative Analysis (chiefly laboratory work). *Mon., Wed., Fri., at 11.* Professor H. B. Hill.

Open only to students who have taken Course 1.

This subject has a much wider scope than the name would indicate. The primary object of the course is undoubtedly to teach the most efficient methods of ascertaining all the constituents of a compound or mixture, but the solution of this problem implies a knowledge not only of the special tests by which each elementary substance or each acid and base is distinguished, but also of the order and manner in which these tests must be applied and of the circumstances under which alone they are trustworthy. Skill and discretion are required in applying the methods, and intelligent knowledge, besides quick observation, in interpreting the results. Hence it is that this subject has always been regarded as one of the most efficient means of chemical training, and it was the first branch of chemical study that was brought into an effective form for class teaching in the laboratory of Liebig. Moreover, the study of Qualitative Analysis brings into prominence qualities of the elementary substances which have little significance in a course on general chemistry, and thus tends to widen the student's knowledge of chemical relations. Indeed every problem in Qualitative Analysis presents to the student a field for investigation in which he must use his knowledge, ingenuity, and skill. The appearances are often baffling and the results doubtful, demanding for their interpretation caution and good judgement, with the strictest regard to exact truthfulness; and such experience is the best training possible for the experimental investigator. The only text-book required in the course is the small laboratory manual of Professor Hill; but the text-books on general chemistry referred to above will be of use for reference, and the student should seek to make his knowledge as real as possible by acquiring an intimate acquaintance with the substances with which he deals. The danger is that these substances should remain mere names distinguished only by certain empirical tests, and the student should earnestly avoid a mechanical routine.

4. Quantitative Analysis (chiefly laboratory work). ***Mon., Wed., at 3.30.*** **Professor COOKE and Dr. RICHARDS.**

Course 4 may be taken with Course 3, but otherwise is only open to students practised in Qualitative Analysis.

This is a purely technical course. As the name denotes, its object is to teach the methods by which in a given body the proportions of its ingredients — previously pointed out by Qualitative Analysis or otherwise — may be accurately determined, and to give practice in such work. This work implies skilful manipulation and a knowledge of the conditions under which alone accuracy can be attained. It demands also constant thought and good judgment in following directions or in varying methods to meet unusual conditions. It is the aim of the teaching to associate the details of the processes with the known qualities of the substances handled. Nevertheless the methods are to a large extent empirical and the subject is not to be recommended as a part of a course of general education. Quantitative Analysis, however, is the great tool of chemical investigation and familiarity with its methods is absolutely essential, not only to the professional chemist but also to all who are engaged in chemical industries. The instruction is given by lectures, but Fresentius' Text Book (last American edition) is used for reference. It is impossible to cover more than a very small fraction of the ground embraced by that work in a single college course. But the aim is to deal with such methods as are most instructive and typical; and thus to give the student that practice which will enable him to follow successfuly the directions in regard to any other methods he may subsequently meet.

Courses in Chemistry for Graduates and Undergraduates.

4a. Quantitative Analysis (*second course*). — Laboratory work. *Mon., Wed., Fri., at 3.30.* Professor H. B. HILL and Dr. RICHARDS.

The professional chemist requires more practice in Quantitative Analysis than can be obtained in a single college course and this second course on the same subject was established to supply this need. It deals more especially with technical methods, such as are used in chemical industries; but, as in the previous course, only a selection of these methods can be treated and this selection is varied from time to time as occasion suggests or to meet special needs.

5. The Carbon Compounds. — Lectures and laboratory work. *Mon., Wed., Fri., at 9.* Professor H. B. HILL.

Course 5 is open only to students who have taken Course 3.

This course covers the field which is generally known as that of Organic Chemistry. It deals with a class of bodies whose properties and relations depend not so much on the nature of the few elementary substances of which they consist, or even on the proportions in which these elements are combined, as they do on the order or manner in which the several constituents are united. It refers the differences of qualities to differences of molecular structure and a main feature of the course is a discussion of the evidencs of such structure. It is a course of high theoretical importance and introduces the student to some of the most transcendental problems of modern chemistry.

8. Chemical Philosophy. *Half-course. Th., at 12.* Dr. RICHARDS.

This course is required of all candidates for Final Honors in Chemistry. It has long been a requisition for Final Honors in this department that the student should pass an examination in Chemical Philosophy. There is a marked tendency among laboratory students to neglect the philosophical and descriptive branches of the science, arising doubtless from the circumstance that the study of chemistry is chiefly attractive to those whose natural gifts enable them to excell in delicate manipulation and skilful contrivance more readily than in abstract thought or the acquisition of facts. But obviously the department cannot bestow its higher honors for mere handicraft, however excellent; and hence the necessity of the requisition. Course 8 was first established in 1890–91 in order to give form and definiteness to the preparation for the examination for Honors. It is in part a review of the fundamental principles of chemistry, but it also includes the history of chemical theories and a number of advanced questions which would not be intelligible except to those already somewhat versed in chemical enquiries. The instruction is given by lectures, but Lothar Meyer's Modern Theories, Ostwald's Outlines of General Chemistry, and Ernst von Meyer's History of Chemistry, all in English translation, are recommended for parallel reading. The old compendiums of Lemery or Boerhave, the famous Treatise of Lavoisier, and the works on chemical philosophy by Fourcroy, Davy, Dalton, Dumas, and Wurtz may be advantageously consulted as representing successive stages in the history of the science.

Courses in Chemistry primarily for Graduates.

6. Advanced Problems in Inorganic Chemistry and Chemical Physics, including Thermo-Chemistry, Molecular Weights and Volumes, and Specific Refractive Power. — Lectures and laboratory work. *Mon., Wed., Fri., at 12.* Professor COOKE.

In this course lectures are given by the students in rotation on topics assigned by the Instructor; and the course will not be given unless a class of at least six persons is formed.

The chief feature of this course is the work on Thermo-Chemistry, which occupies at least one half of the whole time. The experimental work on Thermo-Chemistry consists in determining with the calorimeter the heat evolved in various chemical reactions and deducing therefrom what is known as the heat of formation of chemical products. The heat evolved or absorbed in the production of a chemical compound from elementary substances is with certain limitations a measure of the energy with which the constituents are united, and therefore of the stability of the product, and the tendency is towards the formation of those compounds which determine the greatest evolution of heat. We thus gain a new insight into the mechanism of chemical changes and many relations otherwise obscure become intelligible. Moreover, wide chemical knowledge besides ingenuity and experimental skill are required to adapt chemical processes to the conditions of thermal measurement. The additional subjects mentioned above are studied during the necessary interruptions of the chief experimental work; and other subjects, which like these have an important bearing on chemical philosophy, are taken up according as they become prominent in the progress of chemical investigation.

An important feature of this course are the lectures given by the students in rotation at the appointed exercises. As the most trustworthy information on these subjects studied must be sought in special treatises or recent journals, the preparation of these lectures gives the student practice in the consultation of authorities, — while the delivery gives equally good practice in clear statement, an acquisition of the highest importance to the teacher, but which the laboratory student too often leaves uncultivated. Moreover, by this division of work more can be accomplished than would otherwise be possibie. As already shown, all the available sources of information on the subject studied may be profitably studied in this course; but the book most frequently used is Julius Thompsen's Thermochemische Untersuchungen in three volumes, and two copies of each are in the library of the Laboratory.

Courses in Mineralogy primarily for Undergraduates.

2. Systematic Mineralogy. — Lectures at the Museum and practical exercises. *Mon.*, *Wed.*, *Fri.*, *at 10*, and laboratory work as per appointment. Dr. Huntington.

Mineralogy is simply the natural history aspect of chemistry. A mineral is just as much a chemical compound as any laboratory product, only we distinguish minerals by crystaline form and external character rather than by chemical reactions, and the chief interest centres not in the chemical relations of mineral substances, but in their classification and distribution.

To a chemist the main conception of a substance is a susceptibility to certain reactions; to a mineralogist it is a certain crystalline form or structure associated with other external characters. The chemist habitually recognizes a substance by chemical tests, the mineralogist by crystalline form, optical relations, hardness, or other outward characters; but as the chemist is frequently satisfied with external appearances,so the mineralogist constantly resorts to chemical tests — but he usually applies these in a special way by means of the blow-pipe. The chief object in the course is to give practice in distinguishing between mineral species primarily by means of crystalline form and external characters, and secondarily by blow-pipe tests. The course necessarily opens with the study of crystallography, since apart from the chemical composition the crystalline form is the chief distinctive feature of a mineral species. It is true that the analysis of garnet and common feldspar, for example, correspond, although with wide variations in the details of the composition, to certain general chemical formulae; but it is chiefly a definite crystalline form and structure which make certain mineral specimens garnet or feldspar to the mineralogist and individualize these two important mineral species. The study of crystalline form is followed by a discussion of other external characters, and also by practice in blow-pipe testing, which often affords essential aid in discriminating between allied species. Next the mineral species are studied in detail in the order in which they are classified in Dana's Manual of Mineralogy. It is impossible, of course, to cover the whole ground in one college course, but a sufficient number are discussed to give an adequate conception of the order and extent of the mineral kingdom. A special collection has been arranged with which every student is enabled to study actual specimens of each species in sufficient variety to enable him to distinguish between essential characters and accidental variations, When the survey of each family of minerals is finished, trays of specimens are distributed for determination and the examinations as well as the practical exercises, to which credits are assigned, areconducted in a similar way. Success is measured not so much from the correct naming of the specimens as in the ability shown to discriminate between essential and accidental characters. Besides the obvious technical bearing of the knowledge acquired, the course has a general educational value. It enlarges the conception of the material creation, it furnishes an admirable training of the powers of observation, and especially it cultivates that power of discriminating between essentials and accidentals on which successful scientific study so greatly depends.

The instruction in this course is given by lectures, but the System of Mineralogy by James D. Dana and the Manual of Minerology by E. S. Dana are used for reference.

2*a*. *First half-year:* Mineralogy of common rocks, including a study of the characters and distribution of the mineral species constituting ordinary rock. — *Second half-year:* Metallic Ores, including blow-pipe assaying and the simple methods of furnace assaying of gold and silver ores. *Mon. Wed., Fri., at 9, and laboratory work as per appointment.* Dr. HUNTINGTON.

Course 2*a* may be taken during either half-year as a half-course; but as the laboratory accommodations are limited, the consent of the Instructor must be previously obtained.

This is a technical course intended for students of geology or metallurgy who desire to acquire only such a limited knowledge of Mineralogy as will enable them to recognize the common minerals of the rocks or the usual metallic ores. It does not aim to give a comprehensive view of the mineral kingdom or to present the subject in scientific form. During the second term it is proposed to give a limited amount of instruction in assaying. This is an industrial art whose object is to determine in the shortest possible time the value of samples of metallic ores with the approximate accuracy which is alone needed. The processes must be varied with the conditions at different localities, and their industrial application requires special skill and experience which can only be acquired on the ground. All that can be effectively done in a college course is to give such experience with furnace or blow-pipe work as will enable the aspirant, subsequently, to readily acquire in a real workshop the art and skill of the practical assayer. If there are more applicants than the laboratory will accommodate, those will be preferred who have in view such practical work.

Courses in Mineralogy primarily for Graduates.

7. Crystallography and the Physics of Crystals. — Lectures and Practical Exercises. — *First half-year:* Discussion and Measurement of Crystals. — *Second half-year:* Crystal Optics. *Mon., Wed., Fri., at 10.* Professor COOKE.

Either half of the coure may be taken separately. Students proposing to study Petrography are advised to take the second half in connection with Course 2.

This course covers the whole ground of Determinative and Optical Crystallography. It not only discusses the theory of the subject, but gives practice in the measurement and projection of crystal forms and in the determination of optical values. As any student prepared to take the course must already be familiar with the general outlines of this field of study, no further description is necessary. Indeed a preliminary knowledge of the elements of Optics and of so much Descriptive Crystallography as is given in Course 2, in addition to a working knowledge of the elements of mathematics (including plane and spherical trigonometry), is required for the intelligent study of the subject. The introductory chapters of the Manual of Mineralogy by E. S. Dana give a general outline of this course, and contain an excellent summary of working formulae. The volume on Optics in Müller's Lehrbuch der Physik (last edition), Groth's Physikalische Krystallographie, and Miller's Crystallography are also used as text-books.

Courses of Research.

20. To competent students who have acquired the requisite knowledge and practice, the following are offered as subjects of research under the guidance of the Instructors named: —

    (*a*) Determination of Atomic Weights. Professor Cooke.
    (*b*) Aromatic Compounds. Professor Jackson.
    (*c*) Organic Chemistry. Professor H. B. Hill.
    (*d*) Inorganic Chemistry. Professor Jackson.
    (*e*) Mineralogy. Professor Cooke and Dr. Huntington.

At the Laboratories of Boylston Hall and the Mineralogical Museum the Professors will direct advanced students in Chemistry in any other special studies or investigations.

It is, as a rule, useless for a student to undertake a chemical research unless he is able to bestow upon it the greater part of his thought and energy. The work to be of any value must be engrossing, and necessarily excludes for the time being any other correspondingly engrossing subject. In the scale of college credits research-courses in this department, with the consent of the administrative boards, have usually been counted as two or more college courses, and are not practicable for undergraduates in either of the schools on any other basis. No student should undertake a chemical research until he has acquired the knowledge and skill which will enable him of himself to overcome the usual difficulties sure to arise in every such investigation. If he contributes to his teacher's knowledge and ingenuity nothing but manual labor, the work can be of no profit to him, and he had much better be employed on already well-trodden paths in widening his own knowledge and experience. Advanced students who are able to carry forward efficiently chemical investigation are always welcomed at the Laboratories, and the Professors gladly extend to them every facility at their command.

DEPARTMENT OF BOTANY.

Morphology of Plants (Botany 2) is required during the second year of the course of four years in Biology, and is adapted to the needs of those who intend to become professional naturalists or teachers of natural science, or to study medicine. The course is given on Mondays, Wednesdays, and Fridays, from the beginning of the college year until the mid-year, after which it is succeeded by Zoölogy 2. Two or three lectures are given a week; besides attendance on the lectures, the students are required to perform six hours of laboratory work a week on the days above stated. Instruction is given in the method of working with the compound microscope and making microscopic preparations, and a general knowledge of the mode of growth and reproduction in the vegetable kingdom is taught by means of typical plants selected for the purpose.

Botany 20 may be selected by students of the course in Biology during the fourth year, but others are not admitted to the course unless they can produce evidence satisfactory to the instructor that they are well grounded in the subjects taught in Botany 1, 2, 3, and 4. There are no formal lectures in this course and the amount of laboratory work is not definitely fixed, but it should be understood that it is considerable. Each student works independently, and is expected at the end of the year to present a thesis embodying the result of original work. For students in the Scientific School subjects of limited range are selected, since the work must be finished in one year, but the student is required to show by his thesis that he has acquired the power of conducting an original research accurately and scientifically.

1. General introductory course for undergraduates. *Tu., Th., at 10, and laboratory work (second half-year).* Professor Goodale and Mr. Ganong.

This is essentially a comprehensive course, designed both to present the principles of the Science to those who do not intend to follow it as a specialty, and as well intended to serve as an introduction to further botanical study. The lectures, fully illustrated by living material, diagrams, photographs, and models, cover the principles of structure, morphology and classification, together with outlines of the physiology and economic of the higher plants.

The laboratory work, requiring about four hours per week from the average student, is so arranged as to trace the cycle of higher plant life from seed to seed. The regulative as well as the reproductive parts receive proper attention, and every effort is made to emphasize morphological and biological principles as well as anatomical facts. Competent assistants, abundant materials, ample laboratory accomodations, and sufficient tools, including dissecting microscopes, are provided, and great stress is laid upon this part of the course-work.

Although intended primarily for undergraduates of the three lower classes, it may be taken by Seniors and Graduates as an extra.

3. Principles of the Microscopial Anatomy and Physiology of the Higher Plants; special treatment of allied problems in Morphology and Economics. *Tu., Th., at 2.30, and laboratory work.* Professor GOODALE and Mr. GANONG.

This course aims to give a training in histological and physiological methods to those intending to become specialists, as well as opportunity for more detailed study to those who wish to follow the subject beyond the first course.

The laboratory work consists in the study of plant tissues, treated from the point of view of development. The elements are studied, first in detail as to their structure and composition, and then as grouped into tissues, and finally the tissues as grouped into organs. In the second half-year each student studies a special topic, in such a way as to learn how to apply his knowledge and skill to investigation. Later his topic is given a physiological turn, ending with the practical study of physiological principles.

The laboratories are in all respects fully equipped and always open. The work as planned requires from the average student from six to eight hours per week.

The lectures are two-fold; — first, supplementary to the laboratory work which they explain in their broader aspects, and secondly, a special treatment of related topics in morphology and economics.

It is open to graduates and undergraduates, and requires Botany 1 or its equivalent as a preliminary.

4. Cryptogamic Botany. — Lectures and laboratory work. *Half-course. Tu., Th., Sat., at 11 (second half-year).* Asst. Professor THAXTER.

This course, required during the third year of the course in Biology, is a sequel to Botany 2, and is given on Tuesdays, Thursdays, and Saturday, from the mid-year until the final examinations. In this course the student is supposed by means of lectures and laboratory work to acquire a definite knowledge of the orders of cryptogams, attention being paid especially to the lower forms, as fungi and algae.

20*a*. Special advanced, and research course. Laboratory study, conferences, and occasional lectures. Professor GOODALE and Mr. GANONG.

This course, open to Graduates and properly qualified Seniors, is intended for higher training in histological and physiological methods and principles, and as well for research work upon problems in histology, physiology, and economics. Special students and other specialists may be admitted to follow for longer or shorter periods particular lines of investigation. The laboratory, isolated from those of the other courses, is fully equipped with apparatus for the most exact research, and additional tools are procured when required. A full set of working reference books is at hand, and the Herbarium and College Libraries can be freely drawn upon.

There are no regular lectures, but each student's work is under the constant supervision of one of the instructors, and conferences are held when desirable.

DEPARTMENT OF ZOÖLOGY.

GENERAL STATEMENT.

All Zoölogical Courses in the Department of Zoölogy are conducted in the Natural History Laboratories, and the work under the Museum Assistants is carried on in the adjoining Museum of Comparative Zoölogy, which was founded by Professor Louis Agassiz in 1859.

The formal instruction by lectures and laboratory work on Anatomy, Histology, and Embryology is conducted in rooms on the fourth and fifth floors in the northwest section of the Museum. Places for work upon the Museum collections are provided in connection with the rooms of the several Museum Assistants. There are a large number (17) of such rooms where specialists may work under proper restrictions, and have easy access to the collections, which have all been arranged with a view to facilitating special investigations.

The fifth-floor lecture-room has a floor space of 2260 square feet and seats about 250 persons; it has thirteen north and west windows, and is provided with work-tables and microscopes for classes in sections of about 25 each. The room on the fourth floor corresponding in position and size to the lecture-room above is provided with work-tables to accommodate about 40 students. It is also used as a lecture-room, having seats for a class of 75. The laboratories on either side of the one last mentioned have each five windows. The room having a west exposure is for class work in Histology and Embryology; it has a floor space of 1200 square feet, and is furnished with the needed apparatus for advanced microscopial work. The room with north exposure is used exclusively by persons carrying on original investigations in the anatomy and development of animals; it is equipped with the modern appliances for such work. The course in Comparative Osteology is given in the room of the Museum Assistant in Osteology, on the fifth floor.

There are a large series of diagrams (1300) and several cases of anatomical preparations in the laboratories and adjacent halls, as well as an extensive collection of embryological models, which are used in the illustration of lectures.

The books which are most needed in connection with class instruction are in both the Museum Library and the Library of the Zoölogical Laboratories. The latter at present contains about 200 volumes. Besides the zoölogical memoirs embraced in the transactions of learned societies, which are largely stored in the College Library, the Museum Library contains over 23,000 volumes and half as many pamphlets on Zoölogy and Palæontology. It therefore rarely happens that any one engaged on a special topic of research fails to find at his command all the literature on the subject; and in such an event the desired works, if not at hand, are usually included in the regular orders for the increase of the Museum Library. The reading tables of the Museum Library, on which the current periodicals in Zoölogy, Palæontology, and Geology are arranged as soon as received, occupy a space 9 feet wide by 170 feet long and are lighted by twenty-two windows.

The collections of the Museum are in charge of Museum Assistants, who, at the discretion of the Director, afford opportunities for study to persons fitted to make intelligent and proper use of the material. The collections, having been made for the purpose of aiding in the advancement of science, are accessible only to persons who are already capable of making the best scientific use of them.

DESCRIPTION OF COURSES.

The courses, descriptions of which follow, may be divided into three groups. In Group I. are embraced elementary courses intended for undergraduates only; in Group II., courses which are open to both graduates and undergraduates; in Group III., courses which are intended for graduates and courses of research. Undergraduates will be admitted to courses of research only in cases of exceptional proficiency; but graduates are allowed to pursue and count toward the higher degrees any of the courses except those of Group I.

The requirements for entrance to any given course are stated in the description of the course. From these statements the proper sequence of courses is readily made out. *Students intending to give special attention to Zoölogy will do well to select Course 1 in the Freshman year, and Course 2 in the Sophomore year, in order to leave sufficient time for work in more advanced courses. The only way in which Courses 1, 2, and 3 can be taken in less than three years is by electing Courses 1 and 2 in the same year, since Course 3 cannot be taken until Course 2 is finished.* Such students are advised to pursue, in addition to courses in Botany and Geology, elementary courses in Physics and Chemistry early in their undergraduate work, and also to give some attention to freehand drawing. It is even more important that they should be able to read scientific books written in German, as well as those in French. Foreign books should be ordered two or three months before the beginning of the course in which they are needed.

Although microscopes are provided by the University, those students whose means will allow are advised to purchase microscopes of their own. Those wishing advice on this subject should consult the instructors.

1. **Zoölogy.**—Lectures and laboratory demonstrations. Half-course. Tu., Th., and at the pleasure of the Instructor Sat., at 10 (*first half-year*). Professor Mark.

The laboratory demonstrations of Course 1 will occupy each student three hours a week: 9–10 and 11–1, Tu., Th., or Sat., or 2–5, Tu. or Th.

This course is required as an introduction to Zoölogy 2 and Botany 2. It is open to Freshmen, and may be taken with advantage in the same year with Botany 1. It is intended for beginners and those who wish to get a comprehensive view of the subject.

It is a fitting introduction to a more extended work on the subject, and therefore all students who intend to devote a considerable portion of their time to Zoölogy are advised to elect this course in the Freshman year.

The time is divided between topics connected with the morphology and distribution of animals, and an outline of human physiology. In the laboratory work the student is not taught to dissect or prepare objects for study, but is required to study preparations, and to make drawings of the objects studied.

There will be at least two lectures a week, on Tuesdays and Thursdays at 10 o'clock. If there are additional lectures, they will occur at the same hour on Saturdays. The laboratory demonstrations require three hours a week, and must be pursued on Tuesdays, Thursdays, or Saturdays. For this work the class is divided into sections.

This course must be taken before Course 2, but it may be taken at the same time with the course in Botany (Bot. 2) which is the complement of Course 2.

There are no recitations in this course; but each student is expected to procure Huxley's *Lessons in Elementary Physiology* (revised edition, Macmillan & Co., $1.10). The following books, though not required, will be found useful in connection with this course, and students intending to pursue additional courses in Zoölogy are advised to procure one or more of them: Gegenbaur, *Grundzüge der vergl. Anatomie* (Engelmann, Leipzig, 1878, Mk. 14), or the English translation of the same by Bell, *Elements of Comp. Anatomy* (Macmillan & Co., 21*s.*, *out of print*); Claus, *Lehrbuch der Zoologie* (5th ed., Elwert, Marburg, 1891, Mk. 18), or Claus and Sedgwick, *Elementary Text-book of Zoölogy* (2 vols., Macmillan & Co., $8.00). The following are not yet completed: Hatschek, *Lehrbuch der Zoologie*, Lief. 1–3 (Fischer, Jena, 1888–91, Mk. 9.50); Lang, *Lehrbuch* *der vergl. Anatomie*, Abth. 1–2 (Fischer, Jena, 1888–89, Mk. 10.50), or the English translation of the last by Bernard, *Text-book of Comp. Anatomy*, Pt. i. (Macmillan & Co., 1891, $5.50).

2. Morphology of Animals. *Half-course. Mon., Wed., Fri., at 2.30 (second half-year).* Dr. C. B. Davenport.

This course cannot be taken separately from Botany 2. Exceptions from this rule will be allowed only after consultation with and approval by the instructors in Zoölogy 1 and 2 and Botany 2.

This course is open to those only who take or have taken Zoölogy 1. The number of students in the course is necessarily limited, and preference will therefore be given to those who intend to take Botany 4, Zoölogy 3 or 4, or Geology 24, or to study Medicine.

The aim of the two courses is to afford the necessary elementary training for those whose tastes lead them to desire to continue the study of some branch of natural history, either in the later years of college life or after graduation. Since it is required as a preparation for several other electives, it should be taken early in the college course; if possible, in the Sophomore year.

The lectures in this course are given on Mondays and Wednesdays at 2.30 P.M., and occasionally on Fridays at the same hour. The lectures are on the morphology of the more important types of animals; those on a given group follow immediately the corresponding laboratory work, which consists in dissections of representatives of the types selected. Each student is expected to spend six hours a week in the laboratory, and the hours may be arranged by consultation with the instructor, but they must be on the days named.

Students will find Marshall and Hurst's *Practical Zoölogy* (2d ed., 1888, Smith & Elder, 10*s*. 6*d*.), a valuable aid in connection with laboratory work.

3. Comparative Anatomy of Vertebrates. — Lectures and laboratory work. *Tu., Th., Sat., at 9.* Dr. C. B. Davenport.

Course 3 is open to those only who have taken Courses 1 and 2 and Botany 2.

This course is intended for those who are particularly interested in Zoölogy, and also for those who wish to lay a broad foundation for their subsequent study of human anatomy as medical students.

Lectures are given at 9 o'clock on Tuesdays and Thursdays, and, at the option of the instructor, a demonstration or other informal exercise may be held on Saturdays. In the lectures especial attention is given to evidences of the progressive modifications in the structure of the organs of vertebrates exhibited in passing from lower to higher groups.

The laboratory work must be performed on the three days mentioned, and requires at least six hours a week.

It is desirable for those electing this course to be able to read easy German prose. The following text-books are recommended: Wiedersheim's *Lehrbuch der vergleichenden Anatomie der Wirbelthiere* (2d ed., Fischer, Jena, 1886, Mk. 24). For those who are unable to read German, W. N. Parker's English translation of the abridged edition of Widersheim (*Comparative Anatomy of Vertebrates*, Macmillan, 1886, $3.00) is the best substitute for the original. Hertwig's *Lehrbuch der Entwicklungsgeschichte des Menschen und der Wirbelthiere* (3d ed)., Fischer, 1890, Mk. 11), or the English translation (see under Course 5.)

4. Microscopical Anatomy. — Lectures and laboratory work. *Half-course. Mon., Wed., Fri. (first half-year).* Professor MARK and Dr. W. M. WOODWORTH.

Course 4 is preparatory to Courses 5 and 20*a*. It is open to those only who have taken Course 2, and may be taken advantageously either with or after Course 3. It is for those who intend to prepare themselves for making special investigations, either as teachers of Zoölogy, or as physicians. It presupposes an elementary knowledge of animal morphology, and familiarity with the use of the microscope. As the number of students who can be accommodated is small, preference will be given to those preparing to take Course 5 or 20*a*.

In this course instruction is given in methods of investigation. There will be one, or, at the option of the instructor, two lectures a week. The laboratory work should be arranged for the morning hours of Mondays, Wednesdays, and Fridays.

The instructor is to be consulted before electing the course.

Behrens, Kossel u. Schiefferdecker, *Daz Mikroskop* (Braunschweig, 1889, Mk. 9.80 — bound), or Fol's *Lehrbuch d. vergl. mikroscop. Anatomie*, Lief. 1 (Leipzig, Wm. Engelmann, 1884, Mk. 3), and Whitman's *Methods of Research in Microscopial Anatomy and Embryology* (Cassino, Boston, 1885, $3.00), or Lee, *The Microtomist's vade mecum* 2d ed. (London and Philadelphia, 1890), although not required, will be found useful.

5. Embryology of Vertebrates. — Lectures and laboratory work. *Half-course. Tu., Th., Sat. (second half-year).* Professor MARK.

Course 5 is open to those only who have taken Course 4.

The lectures in this course are on the Embryology of Vertebrates. The laboratory work consists in the preparation and study of the chick at successive stages of development. Students should procure Foster and Balfour's *Practical Embryology* (2d ed., Macmillan & Co., $2.60) and

Hertwig's *Lehrbuch der Entwicklungsgeschichte des Menschen und der Wirbelthiere* (3d ed., Fischer, Jena, 1890, Mk. 11), or the English translation of the same by Mark, *Text-book of the Embryology of Man and Mammals* (Swan Sonnenschein & Co., London; Macmillan & Co., New York. 1892).

COURSES OF RESEARCH.

20*a*. Anatomy and Development of Animals. Professor MARK.

This course is designed for those only who are competent, with the aid of the instructor, to carry on some original investigation. Each student selects, with the advice of the instructor, the subject of his research, and the results are embodied in a thesis. The investigations of advanced students, when considered worthy of publication, usually appear in the Bulletin of the Museum.

Persons contemplating this work will find it to their advantage to consult the instructor at an early date, — if possible, as early as the first of April of the preceding academic year.

[20*b*. General Entomology. Professor HAGEN.]

This course is adapted for those who have an elementary knowledge of the structure of animals and plants, and have had some experience in collecting insects. Omitted in 1892–93.

20*c*. Comparative Osteology. Dr. SLADE.

The osteological collection is open to advanced students for special study and investigation under the direction of the Instructor.

For courses in Palæontology see Geology 14 and 24.

MARINE ZOÖLOGICAL LABORATORIES.

The income of the Humboldt Fund (about $400) is applied, with the advice of the Faculty of the Museum, towards the maintenance of one or more persons engaged in study at the Museum, at the Newport Marine Laboratory, or at the Wood's Holl Fish Commission Station.

Several tables of the Newport Marine Zoölogical Laboratory are reserved for advanced students. Two of the tables of the U. S. Fish Commission at Wood's Holl are also at the disposal of the Director of the Museum, to whom application for these tables should be made before the first of May. Candidates should specify their qualifications and the work they intend to carry out.

DEPARTMENT OF GEOLOGY.

The aim of these courses is to afford a succession of studies of a geological nature which may properly occupy the greater part of the time of the student for at least four years, provided he intends to make a special pursuit of either General or Economic Geology. At the same time, the courses numbered 1, 2, 4, 5, and 8, and Chemistry 2*a* and 2, are intended to serve the purpose of those who wish to acquire a knowledge of the outlines of the science for the sake of the general information it may afford.

4. Elementary Geology. — Lectures and special exercises. *Half-course. Wed., Fri., at 12, and an additional hour for special exercises.* Professor SHALER, and Messrs. DODGE and GRISWOLD.

This course may be taken by Seniors as an *extra* only.

The teaching is by lectures, supplemented by special exercises for explanations and review. Dana's "Manual of Geology" (third edition, 1880) is taken as a reference-book. The course gives a general knowledge of geology which may serve as a basis for further study, and includes lectures on the following topics: Origin and nature of the earth's crust; structure and composition of rocks: dynamics of the earth's crust; continental and mountain folds, earthquakes, volcanoes, dykes, and veins; dynamics of the earth's surface; erosion by wind and water; glaciers and glacial periods; transportation of sediments by rivers and ocean currents; deposition of sediments; action of organic forces in erosion and deposition. — Outline of the physical and vital history of the several geological periods. — Relations of geological structure, and of the form and nature of the earth's surface to the history of man; climate; soil; distribution of economic products of the earth.

5. Elementary Geology. — Laboratory and field exercises, with occasional lectures. *Half-course. Two-hour exercises, twice a week.* Dr. HARRIS and Mr. LADD. (IV.)

Course 5 is open to those only who take or have taken Course 4. It is designed espesially for students who intend to take Course 8 in a subsequent year. (See note under Course S 1 below.) Students taking Course 5 must keep one entire morning or afternoon in each week free for field-work.

The laboratory work consists of the study of the following subjects; general physical nature and composition of rocks; disintegration and erosion by the various destructive agencies of air, water, and ice; transportation, deposition, and consolidation of the resulting detritus; structure of the fragmental rocks; stratigraphy; metamorphism; secondary forces and their effects; igneous structures and phenomena, including dykes, volcanoes, etc.; mineral veins; the relation of organic life to the rocks; preservation of organic remains; the study of the chief groups of fossils and their use in determining geological time, with a general account of the structural and historical geology of the United States. These subjects will be studied by means of specimens, photographs, maps, and models. In the fall and spring, the laboratory work is supplemented by field excursions, occupying a half-day each, to places of geological interest in the immediate vicinity.

8. General Critical Geology. — Lectures, field-work, theses and special exercises. *Mon., Wed., Fri., at 9, and eight or more half-day excursions, with an additional hour for special exercises.* Professor SHALER, Asst. Professor WOLFF, and Mr. WOODWORTH.

Course 8 is open to students who have attained satisfactory grades in Courses 4 and 5 (formerly 4*a*) or Course S 1 in the Summer School of Geology (see below). Students taking this course must keep Thursday or Friday afternoon or Saturday morning free for field-work.

The lectures follow Lyell's "Principles of Geology," and treat of the history of the science of geology; continuity of geological forces; the geological aspect of climate; marine and glacial action; volcanic phenomena; earthquakes; evolutionary hypotheses; time ratio, etc.

The field-work will consist of half-day excursions to various localities in the neighborhood of Cambridge, illustrating problems in structural and physical geology.

The class will be divided into sections for special exercises in review and in consultation of reference books.

A subject for a thesis is chosen by each student in December and an outline or brief of its proposed treatment is submitted in January. The thesis must be completed at the close of the second term.

9. Structural and Dynamical Geology of the stratified rocks; with especial reference to the history and results of geological surveying in the United States. — Lectures, reading, and theses. *Twice a week.* Dr. HARRIS.

Geology 8 or S 2 (see below) is required as a preparation.

Lectures twice each week during the first term, with supplementary reading, on the formation, structure and changes of sedimentary rocks, with especial reference to the rocks of the Appalachian mountain system.

In the second term, each student undertakes the investigation of special problems in the library or laboratory; the object of this work being to furnish practice in the use of sources of information, as well as in methods of treatment. Meetings are held once each week for discussion of these problems. At the end of the year the results of each student's investigation are to be presented in the shape of a carefully prepared report.

During the spring recess, some field-work will probably be undertaken in connection with some of these problems in the eastern part of New York State: participation in this is recommended to all who take the course.

22. Advanced geological field-work. — Field and library work, with weekly conferences. Professors SHALER and DAVIS, Asst. Professor WOLFF and Dr. HARRIS.

Geology 8 and Chemistry 2*a* or 2 are required as a preparation; some knowledge of topographical surveying and free-hand drawing is serviceable. Students should also have taken the summer course, Geol. S 2 (see below). It is desired that students in this course shall keep at least one full day in the week open for their field work.

The aim of the course is to give training in the observation and description of geological phenomena. It can advantageously be taken in successive years.

Each student makes special examination of one or more limited districts in eastern Massachusetts, and presents at the end of the year a written report with diagrams and maps illustrating his work. A course of reading designed to give familiarity with American geological literature supplements the field work during the winter months. A written report or thesis is prepared to present the results thus obtained.

Members of this course are expected to attend the regular meetings of the Geological Conference (see below) on Tuesday evening of each week, for reports on the work in progress.

---

1. Meteorology. Two lectures a week (*Wed.*, *Fri.*, *at 10*) with a third hour on *Mon.* between *9* and *12*, for recitations and written exercises, and an additional hour on *Tues.* morning for laboratory work. *Half-course.* (*First half-year.*) Professor DAVIS and Mr. WARD.

The lectures present the subject under the following headings: Phenomena of the atmosphere: Studies of weather maps; weather-elements, winds, clouds, rain, storms. — Physical phenomena of the atmosphere: temperature, pressure, winds, moisture, precipitation. — Storms: cyclones, thunder-storms, tornadoes. — Geographical meteorology: Climate.

The laboratory work consists chiefly in the construction and study of weather maps and meteorological diagrams, the record of meteorological observations, and the examination of climatic charts, with some practice in weather predictions.

2. Physical Geography. — Two lectures a week (*Wed.*, *Fri.*, *at 10*) with a third hour on *Mon.* between *9* and *12*, for recitations and written exercises, and an additional hour on *Tues.* morning for laboratory work. *Half-course.* (*Second half-year.*) Professor DAVIS and Mr. WARD.

The lectures consider the following subjects: The ocean: distribution of water-surface, area, depth, composition, form and deposits of the sea-bottom, temperature, waves, currents, tides. — The land: continental form, plains, rivers, lakes, mountains, volcanic forms, coasts, islands; considered in relation to geographical classification and evolution and to their effect on human development.

The laboratory work is directed to the study of charts and models of the ocean basins, charts of ocean temperature, currents, etc.; models, diagrams, maps and views of various topographic types in different parts of the world.

*20. Physical Geography and Meteorology (second course). — Lectures, library work, and theses. — *Th. at 9, and a second hour at the pleasure of the Instructor.* Professor DAVIS.

This course is open to those who have passed satisfactorily in Geol. 1 or 2; ability to read German and French is desirable. It may be taken as a half-course in the second half-year by those who have done satisfactory work in Geol. 1, in the first half of the same year.

The course is designed to give opportunity for study supplementary to either of the preceding elementary courses; it will consist of individual investigation of certain topics selected by the student with the advice of the Instructor. Geol. 4 and 5 is required and Geol. 8 is recommended in addition to Geol. 2. for those who desire to give especial attention to the physical geography of the land. Written reports on work accomplished are made by each student in the course of the year.

---

14. Palaeontology. — Lectures, laboratory work, and theses. *Wed., Fri., and (at the pleasure of the Instructor), Mon., at 10, and additional laboratory hours.* Professor SHALER and Dr. JACKSON.

This course is open only to those who have passed in Zoölogy 1, Botany 1, and Geol. 4 and 5, and who can read scientific French and German at sight.

The course is intended to give an acquaintance with the geological history of the various organic series, from the point of view of the student of organic life rather than in the way required by the practical geologist. Although intended to be a complete course in itself, it is also meant as an introduction to Historical Geology and Advanced Palaeontology (see below). Special attention is given to the theories concerning the origin and development of animals as far as these questions are brought into view in the palaeontological record. The course varies from year to year, but the following synopsis will give a view of the subjects generally treated. Conditions of organic life; heat, moisture, etc.; laws of the distribution of life on land and sea; conditions of fossilization; metamorphism and the preservation of the geological record; climatal and other evidence afforded by fossils. General history of the five great divisions of the animal kingdom; the development of the motor system in animals; development of the skeletal, nervous, visual, reproductive, and other systems of the five divisions; theories concerning the appearance and disappearance of animals as shown by fossils; palaeontological history of man. Some instruction in palaeo-botany will also be provided.

15. Historical Geology. — Laboratory work and theses. Professor SHALER and Dr. JACKSON.

This course is open only to those who have taken Geol. 8 and 14; Geol. S2 and Zoölogy 2 are also desirable in preparation.

The course is designed particularly for those who intend making a specialty of Geology; its aim is to teach the use of fossils in identifying geological horizons, especially in the North American series of rocks. Students who take this course will be required to spend some weeks in field-work in the eastern part of the United States.

24. Advanced Palaeontology. — Laboratory work and theses. Professor SHALER and Dr. JACKSON.

This course is open to those who have taken Geol. 8 and 14 and Zoölogy 3.

Each student will give his time to the study of the palaeontology of some group of animals or plants. He is expected to take in hand the literature of the subject, to become personally familiar with all the important living and fossil members of the group, and to present the results of his study in a thesis.

For the convenience of students in geology, the following account is here given of the courses in Mineralogy: —

CHEM. 2*a*. *First half-year:* Minerology of common rocks, including a study of the characters and distribution of the mineral species constituting ordinary rock. — *Second half-year:* Metallic Ores, including blowpipe assaying and the simpler methods of furnace assaying of gold and silver ores. *Mon., Wed., Fri., at 9, and laboratory work.* Dr. HUNTINGTON and Mr. ——.

The first half of this course is intended to teach students to distinguish the most common mineral constituents of rocks, and to recognize them in their ordinary associations. The work of the second half-year is concerned with the common metallic ores, and a few useful and ornamental minerals. Instruction is given in a blow-pipe testing and in the simpler methods of assaying and smelting. The instruction in both terms consists of demonstrations with frequent practical exercises, in which proficiency is tested by the ability to describe and distinguish mineral specimens.

Chem. 2*a* is not open to those who have already taken Chem. 2. It may be taken during either half-year as a half-course, but for the second half-year it can only be elected by students who have previously obtained the consent of the instructor, since the laboratory accommodations are limited.

CHEM. 2. Systematic Mineralogy. — Lectures and laboratory work. *Mon., Wed., Fri., at 10.* Dr. HUNTINGTON and Mr. ——.

It is designed to give in this elective a comprehensive view of the mineral kingdom, and at the same time to give practice in observing the characters of minerals and in distinguishing between mineral species. There are three exercises a week, consisting of oral demonstrations with frequent practical exercises by which proficiency is tested. The course opens with the study of crytallography, affording practice in recognizing crystalline forms both as shown by models and as seen on mineral specimens. Next follows the study of the other physical characters of minerals, including the simpler optical relations. Afterwards the chemical characters, especially the blow-pipe reactions of minerals, are examined; and this preliminary study usually occupies the time until the Christmas recess; the rest of the year is devoted to the study of mineral species in detail, comprising all the groups of minerals and all the important and about one third of the known mineral species. This course is peculiarly well adapted to form the habit and train the power of observation.

CHEM. 7. Crystallography and the Physics of Crystals. — Lectures and Practical Exercises. — *First half-year:* Discussion and measurement of crystals. — *Second half-year:* Crystal Optics. *Mon., Wed., Fri., at 10.* Professor COOKE and Dr. HUNTINGTON

Either half of the course may be taken separately.

This course is intended to give a practical knowledge of crystallography, to teach the methods of measuring crystal angles, of determining crystal forms, and of studying the optical relations of crystalline structures. The course involves the study of Miller's system of crystallography, and of the undulatory theory of light, and includes both the theory and the use of the goniometer, the polariscope, and the polarizing microscope. The optical relations of crystals are studied during the second term, and this subject may be taken as a half-course, in the same year with Chemistry 2, by those proposing to study Petrography.

CHEM. 20*e*. Advanced study and research in Mineralogy. — Individual work in the laboratory. Professor COOKE and Dr. HUNTINGTON.

Opportunity is offered in the mineralogical division of the University Museum for advanced study and research in any branch of mineralogical science.

GEOL. 12. Petrography. — Lectures, laboratory work, and theses. *Twice a week, with additional laboratory hours.* Asst. Professor WOLFF.

Course 12 is open to those only who have taken Geol. 4 and 5 and Chemistry 2. It is of advantage to have taken also the latter half of Chemistry 7.

The lectures treat of the structure, composition, classification, origin, geographical distribution, and geological occurrence of the various families of rocks and of the problems of lithological geology. The microscopial characters of the rock-forming minerals and the various methods of petrographical investigation in the field and laboratory are included in the course. The work in the petrographical laboratory supplements the lectures and enables students to form an acquaintance with practical methods of investigation, and their application to geology.

GEOL. 23. Petrographical research in the field and laboratory. — Individual investigation of special problems. Asst. Professor WOLFF.

This course is a continuation of the previous one. It is established in order to give to advanced students an opportunity to undertake original petographical investigation.

[18. Economical Geology. — Lectures, reading, and theses. *Wed., Fri., at 11, and additional laboratory hours.* Professor WHITNEY.]

Omitted in 1892–93.

Course 18 is open only to those who have taken Geology 4 and 5, and Chemistry 2. Geology 8 and 12 are also desirable.

The lectures treat of the following subjects: History and methods of geographical research; outline of the physical geography and geology of the United States; scenographical geology; economic bearing of the physical features of a country — its coast-line, rivers, mountains, etc.; water-supply; thermal and mineral waters; sources of mineral wealth; salt deposits; mineral paints; coal, petroleum, and natural gas; refractory materials; abrasive materials; building-stones, mortars, and cements; the iron and steel industry; valuable metals, the occurrence of their ores, and methods of working them. These resources are considered from the point of view of their economic development, and are illustrated with maps, diagrams, etc.

25. Mineral Veins and Metalliferous Deposits: their mode of occurrence and theories of their origin. — Lectures, reading, and theses. *Half-course. Wed., at 11, and additional laboratory hours.* Professor WHITNEY.

Lectures, with supplementary reading, treating of the structure of veins and other forms of occurence of metalliferous deposits; methods of extracting the ore, etc., with an account of the geological structure and development of the mineral deposits of Cornwall, the Hartz, the copper region of Lake Superior, the gold region of California, and other classical mining regions.

26. Geographical methods and results. *Half-course. Fri., at 11.* Professor WHITNEY.

The object of this course is to make the student acquainted, so far as is possible within the allotted time, with the methods by which geographical knowledge has been obtained. It will include brief sketches of the lives and works of the most eminent geographical explorers and investigators. The course is intended to be a review of the progress of geographical discovery, beginning at the earliest times of which any record remains, and coming down to the most modern. The development of astronomical science, and its application to the determination of geographical positions at sea and on land; the invention of, and improvements in the instrumental appliances used in this kind of work with their bearing on the accuracy of the results obtained; the methods of representing these results on paper in the form of charts and maps; these and many other topics will be treated somewhat at length. This course is intended especially for students and teachers of geography and history, and the most important sources from which information may be obtained, supplementing that given by the lecturer, will be indicated.

GEOLOGICAL CONFERENCE.

The instructors in this department meet the more advanced students in the various courses on Tuesday evenings for the presentation of papers and reports on subjects investigated by the members, with informal comment and discussion by those present. At each meeting there will be one or more leading papers on subjects announced at a previous meeting, and discussion will be directed chiefly to the subjects thus presented. There will be also brief statements of work in progress, and comments on new publications and other matters of interest.

GEOLOGICAL EXCURSIONS.

A number of geological excursions to places in the vicinity of Boston will be conducted by the instructors of the department during the fall and spring. They will be open to all students of the University, whether attending geological courses or not. By attending them in order, a general view of the geology of the district may be obtained.

Excursions to more distant localities of interest are generally undertaken by the instructors in the April recess. Students who contemplate the professional study of geology are invited to join these excursions, as they give opportunity for observation that cannot be secured during term-time.

SUMMER COURSES.

Three courses in Geology are to be given by the several Instructors in the department during the summer of 1893. These courses may be counted for the degrees of A.B., S.B., A.M., Ph.D., or S.D. The first and second courses will be estimated as half-courses; the third course will be regarded as a half-course if pursued for five weeks, and as a full course if continued for ten weeks. Written examinations on the work of the courses will be held in Cambridge early in October for any students who contemplate counting them towards a degree. A fee of $20 is charged for the first or second course, to be prepaid to Mr. CHAS. F. MASON, *Bursar*, Cambridge, Mass. A special circular concerning these courses may be had at the college office.

S1. Elementary course in general physical and structural geology, at Cambridge. — Lectures, laboratory and field-work. — Exercises daily, from July 5 to August 12. Dr. HARRIS and Mr. ——.

This course is parallel to Geol. 4 and 5 and may be taken instead of them in preparation for Geol. 8.

Lectures will be given daily in the University Museum, supplemented by laboratory work on specimens, models, maps, diagrams, and photographs. The afternoons will be spent in short excursions, and occasionally an entire day will be given to field-work. The excursions will be arranged to exemplify the actual structures and phenomena which have been investigated in the morning's laboratory exercise. The course will afford a practical preparation in methods of field-work for those who intend to continue the subject in some future year.

Students should have a hammer, pocket-compass (graduated to degrees), note-book (with stiff covers and pages unruled) and satchel. No text-book is prescribed, but the larger works of Dana, Leconte, or Geikie may be used for reference.

S2. An advanced course in geological field-work: conducted for two weeks each at Utica, N. Y., Catskill, N. Y., and Meriden, Conn., from July 7, to Aug. 17. Dr. Harris and Mr. ——.

This course is open to those who have taken Courses 4 and 5, or Course S1. Though not parallel to Course 8, it will be accepted as its equivalent in preparation for Courses 9 and 22.

At Utica daily excursions will be made to study the fossiliferous Palaezoic rocks of the New York system, beginning near Trenton Falls and crossing Oneida county to Oriskany Falls; specimens will be collected, thickness measured, maps and sections constructed, and origin discussed. At Catskill a considerable portion of the same series of rocks is again found; the structural conditions, which are here more complicated than at Utica, will be investigated and mapped, and cross-sections constructed: the relation of surface form to structure will receive special attention. A day will be given to an excursion into the Catskill mountains. At Meriden the class will study the structure and physical history of the Triassic sandstones and trap-sheets of this part of the Connecticut valley. The indications of extrusion and intrusion of the lava-sheets are discriminated, and the peculiar dislocation that characterize the region are followed in considerable detail.

The equipment for this course is the same as for Geology S1.

S3. Training in field-research, and in the methods of professional Geological field-work. Professors Shaler and Davis and Asst. Professor Wolff.

Students of maturity and training may be furnished opportunity for advanced individual study in connection with the professional work of the several Instructors. For the present season this lies in New England, eastern New York, and northern New Jersey, and concerns the ancient crystalline rocks, the Triassic formation, and the glacial deposits. The results of the work must be presented in the form of a thesis.

DEPARTMENT OF ANATOMY, PHYSIOLOGY, AND PHYSICAL TRAINING.

DESCRIPTION OF COURSES IN PHYSIOLOGY, HYGIENE, HISTORY OF PHYSICAL EDUCATION, APPLIED ANATOMY, ANTHROPOMETRY, ATHLETICS AND GYMNASTICS.

The aims of this department are as follows: —

1. To prepare persons who, with or without a subsequent training in medicine, may intend to seek employment as directors of gymnasiums or instructors in physical training.
2. To educate youths who may need to take particular care of their bodily health, and therefore should have a knowledge of the subjects taught in the course as well as a systematic training in the care of their bodies.
3. To afford in the first two years a suitable general training for young men who may desire afterwards to pursue the study of medicine. The course of these two years has been approved by the Medical Faculty. Students completing this course (four years) will be able to enter the second class at the Medical School and graduate in three years.

A large and well equipped laboratory has been organized for the experimental study of the physiology of exercise. The object of this work is to exemplify the hygiene of the muscles, the conditions under which they act, the relation of their action to the body as a whole as affecting blood supply and general hygenic conditions, and the effects of various exercises upon muscular growth and general health.

The work in the gymnasium gives a systematic and thorough bodily training, and at the same time a familiarity with and drill in the exercises needed for future teaching. Associated with this is the study of human anatomy analytically and synthetically leading to an understanding of the body as a working machine, and the inter-relation of its parts. The students are taught to measure persons and to classify them into types. Corrective exercises are studied and applied.

The course includes studies in biology, physics, chemistry, English and French or German, and thus affords a considerable amount of general culture.

1. The Elementary Physiology of and Hygiene of Common Life, Personal Hygiene, Emergencies. *Half-course. One lecture and one laboratory hour each week throughout the year (or three times a week, first half-year).* Dr. G. W. Fitz.

This is a general introductory course intended to give the knowledge of human anatomy, physiology and hygiene which should be possessed by every student; it is suitable also for those not intending to study medicine or physical training.

2. History of Physical Education. *Half-course. Lecture once a week and a large amount of reading.* Drs. Sargent and G. W. Fitz.

The student is made acquainted with the literature of physical training. The history of the various sports is traced and the artistic records (statuary, etc.) studied.

3. Physiology of Exercise. — Experimental work, original work and thesis. *Laboratory work six hours a week.* Dr. G. W. Fitz.

This course is intended to introduce the student to the fundamental problems of physical education and to give him the training in use of apparatus for investigation and in the methods in such work.

Course 3 must be preceded by the course in General Physiology at the Medical School or its equivalent.

4. Anthropometry. — Measurements and Tests of the Human Body, Effects of Age, Nurture and Physical Training. — Lectures and practical exercises. *Half-course. Three times a week (first half-year).* Dr. Sargent.

This course affords systematic training in making measurements and tests of persons for the purpose of determining individual strength and health deficiencies. Practice is also given in classifying measurements, forming typical groups, etc., and in determining the relation of the individual to such groups.

This course must be preceded by the course in General Anatomy at the Medical School, or its equivalent.

5. Applied Anatomy and Animal Mechanics. — Action of Muscles in Different Exercises. — Lectures and Demonstrations. *Half-course. Three times a week (second half-year).* Dr. Sargent.

The muscles taking part in the different exercises and the mechanical conditions under which they work are studied. The body is considered as a machine. The development of force, its utilization and the adaptation of the different parts to these ends are made prominent in the work.

This course must be preceeded by the course in General Anatomy at the Medical School, or its equivalent.

6. Remedial Exercises. — The Correction of Abnormal Conditions and Positions. — Lectures and Demonstrations. *Half-course. Twice a week (second half-year).* Dr. G. W. Fitz.

Deformities such as spinal curvature are studied and the corrective effects of different exercises observed. The students are trained in the selection and application of proper exercises, and in the diagnosis of cases when exercise is unsuitable.

7. Gymnastics and Athletics. Dr. Sargent and Mr. J. G. Lathrop.

Systematic instruction is given throughout the four years in these subjects. The students attend the regular afternoon class in gymnastics conducted by Dr. Sargent, work with the developing appliances to remedy up their own deficiencies and take part in the preliminary training for the various athletic exercises under Mr. Lathrop's direction. Much work is also done with the regular apparatus of the gymnasium.

Summer Course in Physical Training.

This course, while designed for teachers, is also open to those desiring the work for their personal improvement; it is conducted at the Hemenway Gymnasium, by D. A. Sargent, M.D., Director, who takes part in both the theoretical and practical instruction.

The theoretical work of the course at the last session comprised lectures and practical talks, with illustrations, on the elements of Applied Anatomy and Physiology, Physical Training, Personal Hygiene, Anthropometry, Physical Examinations and Diagnosis, Methods of Prescribing Exercises for the Individual, Influence of Exercise on the Nervous System, Physical Exercise in the Treatment of Spinal Curvature, Testing for Normal Vision and Hearing, and Massage and its Applications, with the opportunity for practice in Measuring and the use of Testing and Developing Appliances, etc.

The practical work consisted of Free Movements, Calisthenics, Light Gymnastics, Marching, Methods of conducting Squad, Class, and Division Exercises, Relaxing Exercises, Delsarte Movements, Gymnastic Games, Swedish Gymnastics. Heavy Gymnastics, Track and Field Athletics, Boxing, Fencing, Swimming, Voice Training, and Exercises prescribed for special needs on Developing Appliances.

A general certificate, indicating the manner in which his or her work is performed, is given to each student attending the full course; and special certificates are given to those passing examinations at the end of the course.

The Special Lecturers were: Dr. Clarence J. Blake, Dr. Henry P. Bowditch, Dr. Elliot G. Brackett, Dr. Edward Cowles, Dr. Thomas

Dwight, Dr. George W. Fitz, Dr. Lena V. Ingraham, Dr. Myles Standish, Dr. Samuel G. Webber.

The Special Instructors were: Maud M. Babcock, Harriet I. Ballintine, John E. Doldt, Christian Eberhard, James D. Hill, Capt. Thomas D. Landon, James G. Lathrop, Gen. Frederick W. Lister, Hartvig Nissen, Mary Willits, A.B., Jennie B. Wilson; and nine Student Assistants.

Fees: Full course, $50; course in practice, $25; course in theory, for those unable to take the exercise, $25; payable, on entering, to the Bursar of the University.

Announcements regarding the next session and other particulars will be furnished on application to Dr. D. A. Sargent, Cambridge, Mass.

T
171
.H34

Harvard University.

CIRCULAR

OF THE

LAWRENCE SCIENTIFIC SCHOOL.

1893–94.

ADMINISTRATIVE BOARD.

NATHANIEL S. SHALER, S.D., DEAN, *and Professor of Geology.*

HENRY B. HILL, A.M., *Professor of Chemistry.*

IRA N. HOLLIS, *Professor of Engineering.*

EDWIN H. HALL, PH.D., *Assistant Professor of Physics.*

PAUL H. HANUS, S.B., *Assistant Professor of the History and Art of Teaching.*

JOHN E. WOLFF, PH.D., *Assistant Professor of Petrography.*

GEORGE W. FITZ, M.D., *Instructor in Physiology and Hygiene.*

COMMITTEE OF ADVISERS.

NATHANIEL S. SHALER, S.D., DEAN, *and Professor of Geology.*

IRA N. HOLLIS, *Professor of Engineering.*

ROBERT W. WILLSON, PH.D., *Instructor in Astronomy and Physics.*

GEORGE W. FITZ, M.D., *Instructor in Physiology and Hygiene.*

COMFORT A. ADAMS, JR., S.B., *Instructor in Electrical Engineering.*

COMMITTEE ON ADMISSION FROM SCIENTIFIC SCHOOLS AND COLLEGES.

N. S. SHALER.   I. N. HOLLIS.   P. H. HANUS.

MONTAGUE CHAMBERLAIN, *Secretary.*

GENERAL ACCOUNT OF THE SCHOOL.

The Lawrence Scientific School, together with Harvard College and the Graduate School, is under the control of the Faculty of Arts and Sciences of Harvard University. The instruction in these departments is given by the same teachers, mostly in classes which may be attended by pupils from any one of these schools. The life of the students in all three departments is in common; they share alike in all the advantages which the academic department of the University can afford them. So far as their plans may make it desirable, they are allowed without additional charge to attend lectures in the Professional Schools of the University.

The essential peculiarity of the Scientific School, as compared with the other schools which are managed by the Faculty of Arts and Sciences, is that the instruction which it provides for its students is arranged in groups of definite required courses or departments, each of which is intended to afford in a four years' course of study the training necessary for one of the scientific professions, such as Engineering, Chemistry, Geology, etc. While with the consent of the Administrative Board of the School changes may be made in any of the prescribed courses in order to meet the particular needs of the individual student, the plan of these courses leading to the degree of Bachelor of Science must in general be adhered to. Students are, however, permitted, without additional charge, to attend any other instruction in addition to their required work which they may be fitted to pursue, except the exercises in special laboratories.

ADVANTAGES OF THE SCHOOL.

The School is a constituent part of Harvard University, and as such has the general advantages afforded by that institution. It is situated in Cambridge, a city of about eighty thousand inhabitants, at a distance of three miles from Boston, Mass. The city of Cambridge occupies a wholesome territory, and its sanitary state is good; it has been remarkably exempt from contagious diseases; during the several epidemics of cholera which have affected this country, the malady has appeared in but one household. In the United States census of 1880, it held the first place as regards healthfulness in the list of forty-three cities. The College buildings, including the dormitories, are subject to a careful sanitary inspection.

UNIVERSITY INSTITUTIONS.

The Libraries of the University contain over 400,000 bound volumes, and an equal number of pamphlets and maps. In Boston, the collections of the Public Library, the Athenaeum, the Boston Society of Natural History, and other institutions accessible to students, contain a yet larger total number of books.

The University maintains the following scientific establishments and museums: a general establishment known as the University Museum, which contains the collections and laboratories belonging to the departments of Zoölogy, Botany, Geology, and Mineralogy, and has a floor area of four acres, excluding entries and staircases; an Astronomical Observatory; a Museum of American Archaeology; a Semitic Museum; a Botanic Garden and Herbarium, the former occupying an area of about seven acres of land and exhibiting more than five thousand species of flowering plants; a series of Chemical Laboratories which occupy the whole of Boylston Hall, and which provide instruction in the various branches of that science; the Jefferson Physical Laboratory and Museum of Apparatus for instruction in the departments of light, heat, electricity, etc.; a workshop devoted to instruction in Applied Electricity; a Physiological Laboratory for researches and instruction in the course on Anatomy, Physiology, and Physical Training; a Laboratory of Psychology. The extensive laboratories of the Medical, Dental, and Veterinary Schools are situated in Boston; the Bussey School of Agriculture and the Arnold Arboretum, in West Roxbury, about six miles south of Cambridge.

Arrangements have been made with the Rindge Manual Training School of Cambridge for the instruction of students of the Scientific School in workshop appliances.

For the Physical Culture of the students the University has provided the following establishments: the Hemenway Gymnasium for indoor exercises and instruction in physical culture; the Carey Building, for the training of those who may undertake competitive exercises; two boat-houses, on the banks of the Charles River, in the immediate neighborhood of the College grounds; four fields for athletic sports and exercises, containing a total area of about one hundred acres.

Students attending the School may lodge in the dormitories or in private houses, a list of which will be sent on application to the Secretary. They may take their meals either in Memorial Hall, which affords accommodation for about 1100 persons; in the Foxcroft, which provides for about 250; or in private boarding houses.

Each student in the Scientific School has one of its officers designated as his adviser, to whom he is to look for counsel concerning the conduct of his studies and such other assistance as he may need during his residence at the University.

REQUIREMENTS FOR ADMISSION.

Candidates for admission will be examined in the following subjects: Algebra, Plane Geometry, Solid Geometry, Physics, History, German or French, English. In 1894 Trigonometry will be accepted in place of Solid Geometry.

Candidates who pass an examination at entrance in Advanced Algebra, Plane Trigonometry and Logarithms, or Analytical Geometry, will receive credit for these subjects and will not be required to take them in course.

ADMISSION TO ADVANCED STANDING.

A candidate may be admitted to advanced standing by passing examinations in the studies already presented by the class for which he offers himself, in addition to the entrance examinations.

Students of other institutions who have pursued courses parallel to those required in any department of the Lawrence Scientific School, may be admitted to advanced standing on conditions to be determined by a committee of the Faculty appointed for that purpose.

SPECIAL STUDENTS.

Persons of sufficient maturity and education who may not pass the entrance examinations, but who intend, so far as their previous training may admit, to pursue a course of study in general corresponding to one of the departments of the School, or who may desire to devote their time to some special branch of science; are admitted without examination. Such persons are not ranked as candidates for a degree.

Persons who propose to enter the School at advanced standing or as special students should write to the Secretary for blanks on which to make their application.

INSTRUCTION.

Courses of study are provided in the following departments: Civil Engineering; Electrical Engineering; Mechanical Engineering; Chemistry; Geology; Biology; General Science; Anatomy, Physiology, and Physical Training; and in Architecture.

DEGREES.

The degree of Bachelor of Science will be conferred upon any student who satisfactorily completes the work prescribed in the several departments. The grade of the degree and the study for which the degree is given will be specified in the diploma.

For requisitions for the degree of Doctor of Science inquire of the Secretary.

SCHOLARSHIPS.

Sixteen University Scholarships, of the annual value of $150 each, have been established. A portion of these are available for students at the time of their entrance.

There are also eight scholarships, of the annual value of $150 each, for the benefit of graduates of reputable normal schools in the United States who may desire to enter the School.

Graduates of the Scientific School may be appointed to several of the Fellowships and Scholarships available for graduate students.

FEES AND EXPENSES.

The tuition fee for the academic year in any department of the School is $150. The other expenses depend to a great extent upon the tastes and means of the student. They may in general be said to be from $250 to $500 per annum.

Students in Chemistry are supplied with all the needed apparatus, but are required to restore it in as good condition as when received. They are charged for all damage or breakage, and also from $10 to $30 per annum for chemicals and use of apparatus.

Students in Engineering provide their own drawing materials.

The Hemenway Gymnasium, the Scientific School Library, and the College Library are open to members of the School without extra charge.

For complete Catalogue of the School and descriptive pamphlets of the different departments, students' expenses, etc., and for further information, address MONTAGUE CHAMBERLAIN, *Secretary*, Lawrence Scientific School, Cambridge, Mass.

APR 3 1926

UNIV. OF MICH.
DEC 3 1909

T
171
.H34

Harvard University

CIRCULAR

OF THE

LAWRENCE SCIENTIFIC SCHOOL

FEBRUARY, 1895

WILLIAM JAMES, M.D., PH.D. et LITT.D., *Professor of Psychology.*
CHARLES L. JACKSON, A.M., *Professor of Chemistry.*
FRÉDÉRIC C. DE SUMICHRAST, *Assistant Professor of French.*
JOHN W. WHITE, PH.D., *Professor of Greek.*
WILLIAM M. DAVIS, M.E., *Professor of Physical Geography.*
HENRY B. HILL, A.M., *Professor of Chemistry, and Director of Chemical Laboratory.*
FRANCIS G. PEABODY, D.D., *Professor of Christian Morals.*
WILLIAM E. BYERLY, PH.D., *Professor of Mathematics.*
EPHRAIM EMERTON, PH.D., *Professor of Ecclesiastical History.*
CHARLES R. LANMAN, PH.D., *Professor of Sanskrit.*
EDWARD L. MARK, PH.D., *Professor of Anatomy.*
EDWARD S. SHELDON, A.B., *Professor of Romance Philology.*
SILAS M. MACVANE, A.B., *Professor of History.*
ROBERT W. WILLSON, PH.D., *Instructor in Astronomy.*
JOHN H. WRIGHT, A.M., *Professor of Greek.*
ROBERT L. SANDERSON, *Assistant Professor of French.*
LE BARON R. BRIGGS, A.M., *Dean of Harvard College, and Professor of English.*
KUNO FRANCKE, PH.D., *Assistant Professor of German Literature.*
EDWIN H. HALL, PH.D., *Assistant Professor of Physics.*
DAVID G. LYON, PH.D., *Professor of Divinity, and Curator of the Semitic Museum.*
JOSIAH ROYCE, PH.D., *Professor of the History of Philosophy.*
PHILIPPE B. MARCOU, PH.D., *Instructor in Romance Languages.*
CHARLES P. PARKER, A.B., *Instructor in Greek and Latin.*
BENJAMIN O. PEIRCE, PH.D., *Professor of Mathematics and Natural Philosophy.*
HANS C. G. VON JAGEMANN, PH.D., *Assistant Professor of Germanic Philology.*
BARRETT WENDELL, A.B., *Assistant Professor of English.*
EDWARD CHANNING, PH.D., *Assistant Professor of History.*
CHARLES GROSS, PH.D., *Assistant Professor of History.*
PAUL H. HANUS, S.B., *Assistant Professor of the History and Art of Teaching.*
IRA N. HOLLIS, *Professor of Engineering.*
HUGO K. SCHILLING, PH.D., *Assistant Professor of German.*
FRANK W. TAUSSIG, LL.B., PH.D., *Professor of Political Economy.*
JOHN E. WOLFF, PH.D., *Assistant Professor of Petrography.*
ALBERT B. HART, PH D., *Assistant Professor of History.*
H. LANGFORD WARREN, *Assistant Professor of Architecture.*
WILLIAM J. ASHLEY, A.M., *Professor of Economic History.*
MORRIS H. MORGAN, PH.D., *Assistant Professor of Greek and Latin.*

ALBERT A. HOWARD, Ph.D., *Assistant Professor of Latin.*
GEORGE L. KITTREDGE, A.B., *Professor of English.*
ROLAND THAXTER, Ph.D., *Assistant Professor of Cryptogamic Botany.*
EDWARD CUMMINGS, A.M., *Assistant Professor of Sociology.*
ARTHUR R. MARSH, A.B., *Assistant Professor of Comparative Literature.*
HUGO MÜNSTERBERG, Ph.D., M.D., *Professor of Experimental Psychology.*
HENRY L. SMYTHE, A.B., C.E., *Instructor in Geological Surveying.*
ERNEST L. CONANT, A.M., LL.B., *Instructor in Law.*
LEWIS E. GATES, A.B., *Instructor in English.*
ROBERT T. JACKSON, S.D., *Instructor in Palaeontology.*
JAMES L. LOVE, A.M., *Instructor in Mathematics.*
MAX POLL, Ph.D., *Instructor in German.*
JOSEPH TORREY, Jr., A.M., *Instructor in Chemistry.*
JOHN H. GARDINER, A.B., *Instructor in English.*
HAMMOND LAMONT, A.B., *Instructor in English.*
WILLIAM F. OSGOOD, Ph.D., *Assistant Professor of Mathematics.*
THEODORE W. RICHARDS, Ph.D., *Assistant Professor of Chemistry.*
WALLACE C. SABINE, A.M., *Instructor in Physics.*
GEORGE SANTAYANA, Ph.D., *Instructor in Philosophy.*
GEORGE P. BAKER, A.B., *Instructor in English.*
GEORGE W. FITZ, M.D., *Assistant Professor of Physiology and Hygiene, and Medical Visitor.*
JEFFERSON B. FLETCHER, A.M., *Instructor in English.*
HERMAN W. HAYLEY, Ph.D., *Tutor in Latin.*
BYRON S. HURLBUT, A.M., *Instructor in English.*
LEWIS J. JOHNSON, A.B., C.E., *Instructor in Civil Engineering.*
MAXIME BÔCHER, Ph.D., *Assistant Professor of Mathematics.*
CHARLES B. DAVENPORT, Ph.D., *Instructor in Zoölogy.*
COMFORT A. ADAMS, Jr., S.B., *Instructor in Electrical Engineering.*

OTHER INSTRUCTORS, AND ASSISTANTS.

DANIEL D. SLADE, A.B., M.D., *Lecturer on Comparative Osteology.*
JOHN J. HAYES, *Instructor in Elocution.*
GEORGE S. RICE, S.B., *Instructor in Sanitary Engineering.*
WILLIAM E. McCLINTOCK, *Instructor in Highway Engineering.*
JEAN ANTOINE MURE, A.B., S.B., M.D., *Instructor in French.*
JAMES G. LATHROP, *Instructor in Athletics.*
ALPHONSE BRUN, Ph.B., *Instructor in French.*

BENJAMIN RAND, PH.D., *Assistant in Philosophy.*
ALFRED B. NICHOLS, A.B., D.B., *Instructor in German.*
CHARLES T. COPELAND, A.B., *Instructor in English, and Lecturer on English Literature.*
H. CONRAD BIERWIRTH, PH.D., *Instructor in German.*
HERBERT V. ABBOTT, A.B., *Assistant in English.*
JOHN W. BEMIS, A.B., *Assistant in Architecture.*
A. LAWRENCE ROTCH, S.B., A.M., *Assistant in Meteorology.*
HENRY L. COAR, A.M., *Instructor in Mathematics and German.*
A. MARIN MESLÉE, A.B., *Instructor in French.*
CHARLES H. ASHTON, A.M., *Instructor in Mathematics.*
ARCHIBALD C. COOLIDGE, PH.D., *Instructor in History.*
PAUL E. MORE, A.M., *Assistant in Indo-Iranian Languages.*
GEORGE H. PARKER, S.D., *Instructor in Zoölogy.*
EUGENE T. ALLEN, PH.D., *Assistant in Chemistry.*
WILDER D. BANCROFT, PH.D., *Instructor in Chemistry.*
FRED B. JEWETT, A.B., M.D., *Assistant in Physiology and Hygiene.*
RICHARD C. MANNING, A.M., *Instructor in Latin.*
WIRT ROBINSON, LIEUT. U. S. A., *Instructor in Military Science.*
FRANK B. WILLIAMS, A.M., *Instructor in Roman Law.*
WILLIAM McM. WOODWORTH, PH.D., *Instructor in Microscopical Anatomy.*
IRVING BABBITT, A.M., *Instructor in French.*
LEON S. GRISWOLD, A.B., *Instructor in Geology.*
WILLIAM V. MOSES, S.B., *Instructor in Drawing and Machine Design.*
ROBERT DEC. WARD, A.M., *Assistant in Meteorology.*
WILLIAM N. BATES, PH.D., *Instructor in Greek.*
JOHN H. BOYNTON, A.M., *Assistant in English.*
RAYMOND CALKINS, A.M., *Instructor in German.*
RICHARD E. DODGE, A.M., *Instructor in Geology.*
GEORGE A. DORSEY, PH.D., *Assistant in Anthropology.*
CHARLES R. EASTMAN, PH.D., *Assistant in Palaeontology.*
FRANK D. CHESTER, PH.D., *Assistant in Semitic Languages.*
FREDERICK R. CLOW, A.M., *Instructor in Political Economy.*
JOHN CUMMINGS, PH.D., *Instructor in Political Economy.*
WILLIAM F. HARRIS, A.M., *Assistant in Classics.*
HERBERT M. RICHARDS, S.B., *Assistant in Botany.*
FRED N. ROBINSON, PH.D., *Instructor in English.*
HARRIS E. SAWYER, A.M., *Assistant in Chemistry.*
HOWARD B. SHAW, E.B., A.M., *Assistant in Electrical Engineering.*
DANIEL L. TURNER, C.E., *Instructor in Surveying and Railroad Engineering.*

JAY B. WOODWORTH, S.B., *Assistant in Geology.*
REGINALD A. DALY, S.B., A.M., *Assistant in Geology.*
FREDERICK L. DUNLAP, S.B., *Assistant in Chemistry.*
PERLEY L. HORNE, A.B., *Assistant in History.*
HERBERT L. JONES, A.M., S.M., *Assistant in Botany.*
LIONEL S. MARKS. M.E., *Instructor in Mechanical Engineering.*
EDGAR PIERCE, A.M., *Assistant in Psychology.*
GEORGE O. VIRTUE, A.M., *Instructor in Political Economy.*
WILLIAM DUANE, A.B., *Assistant in Physics.*
FRANK E. FARLEY, A.M., *Assistant in English.*
FRANK B. GALLIVAN, A.B., *Assistant in Chemistry.*
JESSE M. GREENMAN, S.B., *Assistant in the Herbarium.*
THOMAS HALL, Jr., A.B, *Assistant in English.*
JOHN G. HART, A.M., *Assistant in English.*
FREDERICK C. McLAUGHLIN, A.B., *Assistant in Physics.*
WILLIAM V. MOODY, A.M., *Assistant in English.*
ENOCH H. VICKERS, A.M., *Assistant in History.*
OSWALD G. VILLARD, A.B., *Assistant in History.*
GEORGE P. WINSHIP, A.M., *Assistant in History.*
CHARLES L. YOUNG, A.B., *Assistant in English.*
GEORGE F. NEWTON, *Instructor in Designing and Drawing.*
JOSEPH W. BLANKINSHIP, A.B., *Assistant in the Botanical Museum.*
LINDSAY T. DAMON, A.B., *Assistant in English.*
ROBERT J. FORSYTHE, A.B., *Assistant in Chemistry.*
LEWIS D. HILL, A.B.., *Assistant in Physics.*
MARTIN H. ITTNER, PH.B., S.B., *Assistant in Chemistry.*
ARTHUR N. JOHNSON, S.B., *Assistant in Drawing and Descriptive Geometry.*
JAMES E. LOUGH, A.M., *Assistant in Psychology.*
MARTIN MOWER, *Assistant in Fine Arts.*
GEORGE OENSLAGER, A.B., *Assistant in Chemistry.*
MACY M. SKINNER, A.B., *Assistant in Semitic Languages.*
JAMES SULLIVAN, Jr., A.B., *Assistant in History.*
CHARLES T. WENTWORTH, A.B., *Assistant in History.*
CHARLES L. WHITTLE, *Assistant in Mineralogy.*
ALONZO McG. COLLETTE, *Assistant in the Botanical Museum.*
CHAUNCY R. PERRY, *Assistant in Surveying and Drawing.*

THE LAWRENCE SCIENTIFIC SCHOOL.

ADMINISTRATIVE BOARD.

NATHANIEL S. SHALER, S.D., *Dean, and Professor of Geology.*

HENRY B. HILL, A.M., *Professor of Chemistry.*

EDWIN H. HALL, Ph.D., *Assistant Professor of Physics.*

PAUL H. HANUS, S.B., *Assistant Professor of the History and Art of Teaching.*

IRA N. HOLLIS, *Professor of Engineering.*

JOHN E. WOLFF, Ph.D., *Assistant Professor of Petrography.*

GEORGE W. FITZ, M.D., *Assistant Professor of Physiology and Hygiene.*

COMMITTEE OF ADVISERS.

NATHANIEL S. SHALER, S.D., *Dean, and Professor of Geology.*

HENRY B. HILL, A.M., *Professor of Chemistry.*

PAUL H. HANUS, S.B., *Assistant Professor of the History and Art of Teaching.*

IRA N. HOLLIS, *Professor of Engineering.*

JOHN E. WOLFF, Ph.D., *Assistant Professor of Petrography.*

H. LANGFORD WARREN, *Assistant Professor in Architecture.*

GEORGE W. FITZ, M.D., *Assistant Professor in Physiology and Hygiene.*

ROBERT W. WILLSON, Ph.D., *Instructor in Astronomy and Physics.*

CHARLES B. DAVENPORT, Ph.D., *Instructor in Zoölogy.*

COMFORT A. ADAMS, Jr., S.B., *Instructor in Electrical Engineering.*

MONTAGUE CHAMBERLAIN, *Secretary.*

THE SCIENTIFIC SCHOOL.

GENERAL ACCOUNT OF THE SCHOOL.

The Lawrence Scientific School, together with Harvard College and the Graduate School, is under the control of the Faculty of Arts and Sciences of Harvard University. The instruction in these departments is given by the same teachers, mostly in classes which may be attended by pupils from any one of these schools. The life of the students in all three departments is in common: they share alike in all the advantages which the academic department of the University can afford them. So far as their plans may make it desirable, they are allowed without additional charge to attend lectures in the professional schools of the University.

The essential peculiarity of the Scientific School, as compared with the other schools which are managed by the Faculty of Arts and Sciences, is that the instruction which it provides for its students is arranged in groups of definite required courses or departments, each of which is intended to afford in a four years' course of study the training necessary for one of the scientific professions, such as Engineering, Chemistry, Geology, etc. While with the consent of the Administrative Board of the School slight changes may be made in any of the prescribed courses in order to meet the particular needs of the individual student, the plan of these courses leading to the degree of Bachelor of Science must in general be adhered to. Students are, however, permitted, without additional charge, to attend any other instruction in addition to their required work which they may be fitted to pursue, except the exercises in special laboratories.

ADVANTAGES OF THE SCHOOL.

The School is a constituent part of Harvard University, and as such has the general advantages afforded by that institution. It is situated in Cambridge, a city of about eighty thousand inhabitants, at a distance of three miles from Boston, Mass. The city of Cambridge occupies a wholesome territory, and its sanitary state is good; it has been remarkably exempt from contagious diseases; during the several epidemics of cholera which have affected this country, the malady has appeared in but one household. In the United States census of 1880, it held the first place as regards healthfulness in the list of forty-three cities. The College buildings, including the dormitories, are subject to a careful sanitary inspection.

Students attending the School may lodge in the dormitories or in private houses, a list of which will be sent on application to the Secretary. They may take their meals; in Memorial Hall, which affords accommodation for about 1100 persons; in the Foxcroft Club, which provides for about 300, or in private boarding houses.

Each student in the Scientific School has one of its officers designated as his Adviser, to whom he is to look for counsel concerning the conduct of his studies and such other assistance as he may need during his residence at the University.

REQUIREMENTS FOR ADMISSION.

Every candidate for admission is required to furnish a testimonial of honorable dismissal from the school or college which he has attended, or from the tutor with whom he has studied. When a candidate has been in regular attendance at a school or academy during the year preceding his Final Examination, a testimonial from a private tutor will not in itself be sufficient. Testimonials may be presented at the time of the Final Examination.

Candidates for admission will be examined in the following subjects: English, German or French, History, Algebra, Plane Geometry, Solid Geometry, Physics. Candidates who propose to register in the Department of General Science must offer either Experimental Physics or Chemistry, and those who propose to register in the department of Chemistry or in the department of Science for Teachers must offer both Experimental Physics and Chemistry.

English. — In 1895 and thereafter English may be offered either as a Preliminary or as a Final subject. After 1895 the examination in English will occupy two hours.

The candidate will be required to write a short composition on one of several subjects announced at the time of the examination, and also to correct specimens of bad English. In 1895 the subjects for the compositions will be drawn from one or more of the following works: —

Shakspere's Merchant of Venice and Twelfth Night, Milton's L'Allegro, Il Penseroso, Comus, and Lycidas, Longfellow's Evangeline, the Sir Roger de Coverley Papers in the Spectator, Macaulay's Essays on Milton and Addison, Webster's first Bunker Hill Oration, Irving's Sketch Book, Scott's Abbott.

After 1895 the examination will consist of two parts, which, however, cannot be taken separately: —

I. The candidate will be required to write a paragraph or two on each of several topics chosen by him from a considerable number — perhaps ten or fifteen — set before him on the examination paper. In 1896 the topics will be drawn from the following works: —

Shakspere's Midsummer Night's Dream; Defoe's History of the Plague in London; Irving's Tales of a Traveller; Scott's Woodstock; Macaulay's Essay on Milton; Longfellow's Evangeline; George Eliot's Silas Marner.

The candidate is expected to read intelligently *all* the books prescribed. He should read them as he reads other books; he is expected, not to know them minutely, but to have freshly in mind their most important parts. In every case the examiner will regard knowledge of the book as less important than ability to write English.

As additional evidence of preparation, the candidate may present an exercise book, properly certified by his instructor, containing compositions or other written work.

The works prescribed for this part of the examination in 1897 and 1898 are as follwws:—

In 1897: Shakspere's As You Like It; Defoe's History of the Plague in London; Irving's Tales of a Traveller; Hawthorne's Twice Told Tales; Longfellow's Evangeline; George Eliot's Silas Marner.

In 1898: Milton's Paradise Lost, Books I and II; Pope's Iliad, Books I and XII; The Sir Roger de Coverley Papers in the Spectator; Goldsmith's Vicar of Wakefield; Coleridge's Ancient Mariner; Southey's Life of Nelson; Carlyle's Essay on Burns; Lowell's Vision of Sir Launfal; Hawthorne's House of the Seven Gables.

II. A certain number of books will be prescribed for careful study. This part of the examination will be upon subject-matter, literary form, and logical structure, and will also test the candidate's ability to express his knowledge with clearness and accuracy.

The books prescribed for this part of the examination are:

In 1896: Shakspere's Merchant of Venice; Milton's L'Allegro, Il Penseroso, Comus, and Lycidas; Webster's First Bunker Hill Oration.

In 1897: Shakspere's Merchant of Venice; Burke's Speech on Conciliation with America; Scott's Marmion; Macaulay's Life of Samuel Johnson.

In 1898: Shakspere's Macbeth; Burke's Speech on Conciliation with America; De Quincey's Flight of a Tartar Tribe; Tennyson's Princess.

No candidate will be accepted in English whose work is seriously defective in point of spelling, punctuation, grammar, or division into paragraphs.

In connection with the reading and study of the prescribed books, parallel or subsidiary reading should be encouraged, and a considerable amount of English poetry should be committed to memory. The essentials of English grammar should not be neglected in preparatory study.

The English written by a candidate in any of his examination-books may be regarded as part of his examination in English, in case the evidence afforded by the examination-book in English is insufficient.

☞ After 1895 there will be no examination in the correction of bad English.

German or *French*.[*] — The translation at sight either of simple German prose, or of ordinary French prose. The passages set for translation will be similar to those set at the final examinations in German *A* and French *A* respectively, — College courses each having three hours of instruction a week through the year. A knowledge of the language itself, rather than of the grammar, is expected; but proficiency in elementary grammar, or facility in writing the language, will be accepted as an offset for some deficiency in translation. It is recommended that from the outset attention be given to pronunciation.

History (*including Historical Geography*). — Either (1) History of Greece and Rome; or (2) History of the United States and of England.

The following works will serve to indicate the amount of knowledge demanded in History: Oman's History of Greece; Allen's History of the Roman People (the whole), *or* Leighton's History of Rome (to the death of Commodus); Higginson's Young Folks' History of the United States (to the end of Chapter XXI.), and Johnston's History of the United States for Schools (beginning at § 269); Guest and Underwood's Handbook of English History (to the year 1793), or Gardiner's Student's History of England through Part IX.

The following selections are recommended for additional reading and will be made the basis of optional questions in the examination:[†] —

For Greek History: Curtius's History of Greece, Book I. Ch. I., Book II. Ch. IV., and Book III. Ch. III.

For Roman History: Beesly's The Gracchi, Marius, and Sulla; Tighe's Development of the Roman Constitution.

For American History: Lodge's English Colonies, Chapters II. and XXII.; Morse's John Quincy Adams, Chapters II. and III.; Josiah Quincy's Figures of the Past.

---

[*] Candidates from countries in which English is not spoken may defer the entrance examination in French *or* German to the end of their first year of residence.

[†] Candidates who take the questions on the Selections will be allowed to omit some of the questions on the corresponding Manual.

For English History: Macaulay's History of England, Chapters I. and III.

Algebra, through Quadratic Equations. (The requirement in Algebra embraces the following subjects: factors, common divisors and multiples, fractions, ratios and proportions; negative quantities and the interpretation of negative results; the doctrine of exponents; radicals and equations involving radicals; the binomial theorem for positive integral exponents and the extraction of roots; putting questions into equations, and the reduction of equations; the ordinary methods of elimination, and the solution of both numerical and literal equations of the first and second degrees, with one or more unknown quantities, and of problems leading to such equations.)

Plane Geometry.

Solid Geometry. The following book will serve to indicate the nature and amount of the requirements in Solid Geometry:—

Chauvenet's Geometry, revised and abridged (Philadelphia: J. P. Lippincott & Co.). Books VI., VII., VIII., and IX.

Physics.—Either (1) Astronomy (Young's Lessons in Astronomy, Ginn & Co., omitting the appendix) and Physics (Avery's Elements of Natural Philosophy,[*] or Gage's Elements of Physics); or (2) a course of experiments not less than forty in number performed at school by the pupil. These must be selected from a list issued by the University under the title of a Descriptive List of Elementary Physical Experiments, or must be approved by the Department of Physics as the equivalent of those contained in this list.

DEFICIENCIES.

A candidate may be admitted in spite of deficiencies in some of these studies; but no candidate so admitted will be advanced to Third-Year standing in the School until he has made good such deficiencies to the satisfaction of the Administrative Board of the School.

The exact number of deficiencies with which a candidate may be admitted cannot be named in advance, since each case is considered on its merits.

No student in the Engineering courses will be advanced to Second-Year standing until all his admission deficiencies in Mathematics are made good to the satisfaction of the Administrative Board.

---

[*] The following portions of the 1885 edition may be omitted:—sections I. and II. of chap. I. (excepting arts. 23–30), arts. 254–267, 346–349, 371, 411–415, 445–455, 404–467, 470–476, 707–714, 729–745, and the whole Appendix.

OPTIONAL SUBJECTS.

In addition to these *required* subjects there are others, given in the following list, which may well be offered by candidates for the Scientific School. They are called Advanced Studies in the requirements for admission to Harvard College.

Students who have passed the examinations at admission in any of these Advanced Studies, or in any studies required in the School, will be given credit for the courses so passed and may substitute for them others chosen with the approval of the Administrative Board.

Logarithms and Trigonometry. Wheeler's Logarithms (Cambridge: Sever) or the unbracketed portions of Pierce's Elements of Logarithms (Boston: Ginn & Co.). Wheeler's Plane Trigonometry (same publishers). Problems in Plane Trigonometry (Cambridge: Sever). Pierce's Mathematical Tables (Boston: Ginn & Co.).*

Analytic Geometry. Briggs's Analytic Geometry (New York: Wiley & Co.).

Advanced Algebra. Wentworth's College Algebra (Boston: Ginn & Co.), to article 498, omitting Chapters XIX., XX., XXIV., XXV., XXVII., XXVIII. The examination will be occupied mainly with the portions of Algebra, as thus defined, which are not included in the elementary requirement in Algebra; but elementary questions will not necessarily be excluded.

Physics. A course of at least sixty experiments in addition to those of Elementary Physics (2), selected from the same or similar manuals, and covering the same subjects, but demanding more skill and more knowledge of physical theories and laws.

Chemistry. A course of at least sixty experiments in General Chemistry actually performed at school by the pupil.

FORM OF APPLICATION.

Persons who wish to enter the School with Advanced Standing or as Special Students will be furnished with printed forms of application by the Secretary of the *School.* The form must be filled out and returned to the Secretary before the application will be considered by the Administrative Board of the School.

---

* Candidates are required to use at the examinations the four place tables provided by the University.

ADMISSION TO ADVANCED STANDING.

A candidate may be admitted to advanced standing either by passing examinations in all the studies already pursued by the class for which he offers himself, in addition to the entrance examinations; or from another scientific school or college upon such conditions as the Administrative Board may deem equitable in each case, regard being had to the applicant's previous course of study, and to the evidence of proficiency exhibited by him.

The successful study of any subject in Harvard College will be taken as an equivalent for the same subject in the Scientific School; but no graduate of the College will be given a Scientific School degree without at least one full year's work in the School.

SPECIAL STUDENTS.

The courses of study in the Scientific School are open to persons who satisfy the Administrative Board of the School of their fitness to pursue the particular courses they elect, although they have not passed the usual examinations for admission. These students are known as Special Scientific Students; they are members of the School from the time of their admission, but are not candidates for the degrees given by the School.

At the beginning of each year Special Students must submit their choice of studies for approval. They will be required to take each year four full courses selected from among the following: Courses in Mathematics, Engineering, Physics, Chemistry, Geology, Botany, or Zoölogy, and any courses in other departments which are prescribed in the several departments of study for the degree of S.B.

At least one-half of the work of each Special Student must be taken from the regular programme of the department of study in which he registers.

Candidates who cannot otherwise show that they are competent to pursue subjects which are protected by entrance examinations, must pass satisfactory tests before entering these courses.

Exceptional cases may be referred to the Administrative Board by petition.

Special Students are subject to all the regulations of the School. A report of their work is sent to their parents or guardians at the end of the year.

The Administrative Board reserves the right to deprive any Special Student of his privileges at any time, if he abuse or fail to use them.

A certificate of proficiency will be given, if desired, to any Special Student who has faithfully pursued his chosen subjects throughout a year and attained a grade not lower than Grade *B* therein.

DEPARTMENTS OF STUDY.

In 1895, instruction will be given in the following departments:—

Civil and Topographical Engineering.
Electrical Engineering.
Mechanical Engineering.
Mining Engineering.
Architecture.
Chemistry.
Geology.
Botany and Zoölogy.
General Science.
Science for Teachers.
Anatomy, Physiology, and Physical Training.

For complete Catalogue of the School and descriptive pamphlets of the different departments, students' expenses, etc., and for further information, address MONTAGUE CHAMBERLAIN, Secretary, Lawrence Scientific School, Cambridge, Mass.

T
171
.H34

From Radcliffe College
Oct. 19 '98

[illegible] LIBRARY,
[illegible]
20 OCT [illegible]

NEW SYSTEM OF REQUIREMENTS

FOR ADMISSION TO

HARVARD COLLEGE

AND THE

LAWRENCE SCIENTIFIC SCHOOL

REPRINTED FROM THE

HARVARD UNIVERSITY CATALOGUE

1897-98

NEW SYSTEM OF REQUIREMENTS

FOR ADMISSION TO HARVARD COLLEGE AND THE LAWRENCE SCIENTIFIC SCHOOL.

A new system of requirements for admission to Harvard College and to the Lawrence Scientific School is now under consideration. A careful revision has been made of the list of studies covered by the admission examinination and of the requirement in each study. Some new studies have been added to the list; many of the definitions of old studies have been materially amended; and pains have been taken to give full information to teachers and pupils concerning the kind and amount of the preparation which the Faculty seek to secure in each subject. The results of this revision are stated below under the heading "New Definitions of Requirements," which are, however, still subject to possible changes of detail.

In the examinations of 1898, and thereafter until the new definitions shall be exclusively in force, *alternative papers* will be offered under the new definitions (where they differ materially from the present definitions) in Greek, Latin, German, French, History, Mathematics, Physics, and Chemistry.

The terms of admission to Harvard College under the new system are not yet formulated. It is, however, the purpose of the Faculty to assign to each study a certain number of points, representing the relative weight which that study is to have in determining the question of a candidate's fitness for admission, and to state the total amount of the requirement for admission in the form of a fixed aggregate of points, which may be made up by various combinations of studies under regulations to be announced hereafter. It is not the intention of the Faculty to increase the total amount of work required in preparation for Harvard College.

A preliminary statement of the proposed terms of admission to the Lawrence Scientific School will be found on pages 303–306.

NEW DEFINITIONS OF REQUIREMENTS.

GOOD ENGLISH.

Clear and idiomatic English is expected in all examination-papers and note-books written by candidates for admission. Teachers are requested to insist on good English, not only in translations, but in every exercise in which the pupil has occasion to write or to speak English.

1. English.

(As at present.)

The examination will consist of two parts, which, however, cannot be taken separately: —

I. The candidate will be required to write a paragraph or two on each of several topics chosen by him from a considerable number — perhaps ten or fifteen — set before him on the examination paper. In 1898 the topics will be drawn from the following works: —

Milton's Paradise Lost, Books I and II; Pope's Iliad, Books I, VI, and XXII; The Sir Roger de Coverly Papers in the Spectator; Goldsmith's Vicar of Wakefield; Coleridge's Ancient Mariner; Southey's Life of Nelson; Carlyle's Essay on Burns; Lowell's Vision of Sir Launfal; Hawthorne's House of the Seven Gables.

The candidate is expected to read intelligently *all* the books prescribed. He should read them as he reads other books; he is expected, not to know them minutely, but to have freshly in mind their most important parts. In every case the examiner will regard knowledge of the book as less important than ability to write English.

As additional evidence of preparation, the candidate may present an exercise-book, properly certified by his instructor, containing compositions or other written work.

II. A certain number of books will be prescribed for careful study. This part of the examination will be upon subject-matter, literary form, and logical structure, and will also test the candidate's ability to express his knowledge with clearness and accuracy. The books prescribed for this part of the examination in 1898 are:

Shakspere's Macbeth; Burke's Speech on Conciliation with America; De Quincey's Flight of a Tartar Tribe; Tennyson's Princess.

No candidate will be accepted in English whose work is seriously defective in point of spelling, punctuation, grammar, or division into paragraphs.

In connexion with the reading and study of the prescribed books, parallel or subsidiary reading should be encouraged, and a considerable amount of English poetry should be committed to memory. The essentials of English grammar should not be neglected in preparatory study.

The English written by a candidate in any of his examination-books may be regarded as part of his examination in English, in case the evidence afforded by the examination-book in English is insufficient.

2-4. Greek.

2. *Elementary Greek.*

The examination will be adapted to the proficiency of those who have studied Greek in a systematic course of five exercises a week, extending through at least *two* school years. The two parts of the examination cannot be taken separately: —

(*a*) The translation at sight of simple Attic prose. (The passages set for translation must be rendered into simple and idiomatic English.)

(*b*) A thorough examination on a prescribed portion of Xenophon (about thirty pages*), directed to testing the candidate's mastery of the ordinary forms, constructions, and idioms of the language; the test to consist, in part, of writing simple Attic prose, involving the use of such words, constructions, and idioms only as occur in the portion of Xenophon prescribed.

For three years, beginning with 1898, the portion of Xenophon prescribed will be the second book of the Anabasis.

Advanced Greek.

There are two examinations, in either or both of which the candidate may present himself. To be adequately prepared for both examinations, the candidate should have studied Greek in a systematic course of five exercises a week, extending through at least *three* school years: —

3. *Greek Authors.* — The translation at sight of Attic prose and of Homer, with questions designed to test the candidate's understanding of the passages set, and questions on ordinary forms, constructions, and idioms, and on prosody. (The passages set for translation must be rendered into simple and idiomatic English.)

4. *Greek Composition.* — The translation into Attic prose of a passage of connected English narrative. The passage set for translation will be based on some portion of the Greek prose works usually read in preparation for college, and will be limited to the subject-matter of those works.

The estimate of the periods of study necessary to prepare for the elementary and advanced examinations in Greek is based on the assumption that the candidate has begun the study of Latin at least a year earlier, and has continued it along with his Greek course; otherwise the periods specified would not be sufficient.

In preparation for the elementary examination in Greek, candidates should read from 130 to 170 pages* of Attic prose. For the advanced examination (Greek Authors), candidates should read from 30 to 50 pages more of Attic prose, and from 3000 to 5000 verses of Homer. The reading of Homer may be advantageously begun with a thorough study of Iliad, Books I and II (to the catalogue of ships).

The pupil should be constantly guided in proper methods of reading, and trained to read the Greek intelligently, as Greek, before undertaking to render it into idiomatic English. There should be constant practice in reading aloud, with due expression, and in hearing the language read. In connexion with the reading, to ensure thoroughness and accuracy in the pupil's understanding of the language, the study of grammar, with some practice in writing Greek, should be maintained throughout the course. There should also be frequent written translations into idiomatic English.

To prepare for the examination in Greek Composition, pupils should be trained, from an early stage of the preparatory course, to render into Greek, not merely detached sentences, illustrative of constructions, but also passages of connected narrative or description, prepared by the teacher on the basis of the prose authors read.

---

* The pages of the more recent Teubner text editions are taken as a standard in this statement.

5-7. Latin.

5. *Elementary Latin.*

The examination will be adapted to the proficiency of those who have studied Latin in a systematic course of five lessons a week, extending through at least *three* school years. The two parts of the examination cannot be taken separately: —

(*a*) The translation at sight of simple Latin prose and verse. (The passages set for translation must be rendered into simple and idiomatic English.)

(*b*) A thorough examination on a prescribed portion of Cicero's speeches (about thirty pages*), directed to testing the candidate's mastery of the ordinary forms, constructions, and idioms of the language; the test to consist, in part, of writing simple Latin prose, involving the use of such words, constructions, and idioms only as occur in the speeches prescribed.

For three years, beginning with 1898, the portion of Cicero prescribed will be the second, third, and fourth speeches against Catiline.

Advanced Latin.

There are two examinations, in either or both of which the candidate may present himself. To be adequately prepared for both examinations, the candidate should have studied Latin in a systematic course of five lessons a week, extending through at least *four* school years: —

6. *Latin Authors.* — The translation at sight of Latin prose and verse, with questions designed to test the candidate's understanding of the passages set, and questions on ordinary forms, constructions, and idioms, and on prosody. (The passages set for translation must be rendered into simple and idiomatic English.)

7. *Latin Composition.* — The translation into Latin prose of a passage of connected English narrative. The passage set for translation will be based on some portion of the Latin prose works usually read in preparation for college, and will be limited to the subject-matter of those works.

The estimate of the periods of study necessary to prepare for the examinations in Latin is made with reference to schools which have a four years' course. Schools which have a five years' course may more advantageously provide for beginning the study of Latin in the first year, with some diminution, if necessary, of the time devoted to it in the last years of the course.

The course of reading pursued in preparation for the examinations in Latin should include: —

(*a*) Easy reading, included in or following a suitable introductory book ('Latin Lessons'), amounting to from 30 to 40 pages;*

---

* See footnote, p. 290.

(*b*) Nepos (Lives) and Caesar (Gallic War), 90 to 120 pages;

(*c*) Cicero, 90 to 120 pages, including the four speeches against Catiline and the speech on the Manilian Law, with additional speeches selected by the teacher;

(*d*) Virgil and Ovid, 6000 to 10,000 verses, including the first six books of the Aeneid.

Preparation for the elementary examination alone should include (*a*) and (*b*), the four speeches against Catiline, and from 2000 to 3000 verses of Virgil, or of Ovid and Virgil.

The pupil should be constantly guided in proper methods of reading, and trained to read the Latin intelligently, as Latin, before undertaking to render it into idiomatic English. There should be constant practice in reading aloud, with due expression, and in hearing the language read. In connexion with the reading, to ensure thoroughness and accuracy in the pupil's understanding of the language, the study of grammar, with some practice in writing Latin, should be maintained throughout the course. There should also be frequent written translations into idiomatic English.

To prepare for the examination in Latin Composition, pupils should be trained, from an early stage of the preparatory course, to render into Latin not merely detached sentences, illustrative of constructions, but also passages of connected narrative or description, prepared by the teacher on the basis of the prose authors read.

8, 9. German.

8. *Elementary German.*

(*a*) The translation at sight of simple German prose. (The passages set for translation must be rendered into simple and idiomatic English.)

(*b*) The translation into German of simple English sentences, or of easy connected prose, to test the candidate's familiarity with elementary grammar.

The passages set for translation into English will be suited to the proficiency of candidates who have read not less than two hundred pages of easy German (including reading at sight in class).

Grammar should be studied concurrently with the reading as an indispensable means of ensuring thoroughness and accuracy in the understanding of the language. The requirement in elementary grammar includes the conjugation of the weak and the more usual strong verbs; the declension of articles, adjectives, pronouns, and such nouns as are readily classified; the commoner prepositions; the simpler uses of the modal auxiliaries; the elements of syntax, especially the rules governing the order of words.

Pronunciation should be carefully taught, and the pupils should have frequent opportunities to hear German spoken or read aloud. The writing of German from dictation is recommended as a useful exercise.

9. *Advanced German.*

(*a*) The translation at sight of ordinary German. (The passages set for translation must be rendered into simple and idiomatic English.)

(*b*) The translation into German of a connected passage of English prose, to test the candidate's familiarity with grammar. Proficiency in grammar may also be tested by direct questions.

The passages set for translation into English will be suited to the proficiency of those who have read, in addition to the amount specified under Elementary German, not less than five hundred pages of classical and contemporary prose and verse. It is recommended that the reading be selected from such works as the following: Riehl, *Culturgeschichtliche Novellen;* Freytag, *Bilder aus der deutschen Vergangenheit, Die Journalisten;* Kohlrausch, *Das Jahr 1813*; Schiller, *Der dreissigjährige Krieg, Wilhelm Tell, Maria Stuart, Die Jungfrau von Orleans;* Goethe, *Hermann und Dorothea, Egmont, Iphigenie;* Lessing, *Minna von Barnhelm.* About one half of the amount read should be Nineteenth Century prose.

In the translation into German candidates will be expected to show a thorough knowledge of accidence, the elements of word-formation, the principal uses of prepositions and conjunctions, and the essentials of syntax, especially the uses of the modal auxiliaries, and of the subjunctive and infinitive modes.

It is recommended that the candidate be trained to follow a recitation conducted in German and to answer in that language questions asked by the instructor.

10, 11. French.

10. *Elementary French.*

(*a*) The translation at sight of ordinary Nineteenth Century prose. (The passages set for translation must be rendered into simple and idiomatic English.)

(*b*) The translation into French of simple English sentences or of easy connected prose, to test the candidate's familiarity with elementary grammar. Proficiency in grammar may also be tested by direct questions, based on the passages set for translation under (*a*).

The passages set for translation into English will be suited to the proficiency of candidates who have read not less than four hundred pages (including reading at sight in class) from the works of at least three different authors. It is desirable that a portion of the reading should be from works other than works of fiction.

Grammar should be studied concurrently with the reading as an indispensable mean of ensuring thoroughness and accuracy in the understanding of the language. The requirement in elementary grammar includes the conjugations of regular verbs, of the more frequent irregular verbs, such as *aller*, *envoyer*, *tenir*, *pouvoir*, *voir*, *vouloir*, *dire*, *savoir*, *faire*, and those belonging to the classes represented by *ouvrir*, *dormir*, *connaitre*, *conduire*, and *craindre;* the forms and positions of personal pronouns and of possessive, demonstrative, and interrogative adjectives; the inflection of nouns and adjectives for gender and number, except rare cases; the uses of articles, and the partitive constructions.

Pronunciation should be carefully taught, and pupils should have frequent opportunities to hear French spoken or read aloud. The writing of French from dictation is recommended as a useful exercise.

11. *Advanced French.*

(*a*) The translation at sight of standard French. (The passages set for translation must be rendered into simple and idiomatic English.)

(*b*) The translation into French of a connected passage of English prose, to test the candidate's familiarity with grammar. Proficiency in grammar may also be tested by direct questions.

The passages set for translation into English will be suited to the proficiency of candidates who have read, in addition to the amount specified under Elementary French, not less than six hundred pages of prose and verse from the writings of at least four standard authors. A considerable part of the amount read should be carefully translated into idiomatic English.

Candidates will be expected to show a thorough knowledge of accidence and familiarity with the essentials of French syntax, especially the uses of tenses, modes, prepositions, and conjunctions.

It is recommended that the candidate be trained to follow a recitation conducted in French and to answer in that language questions asked by the instructor.

12, 13. History (including Historical Geography).

12. *Elementary History.*

Either of the two following groups, each including two fields of historical study: —

1. *Greek and Roman History.* — (*a*) Greek History to the death of Alexander, with due reference to Greek life, literature, and art. (*b*) Roman History to the accession of Commodus, with due reference to literature and government.

2. *English and American History.* — (*a*) English History, with due reference to social and political development. (*b*) American History, with the elements of Civil Government.

For preparation in each of the two historical fields presented, a course of study equivalent to at least three lessons a week for one year will be necessary.

The candidate will be expected to show on examination such general knowledge of each field as may be acquired from the study of an accurate text-book of not less than 300 pages, supplemented by suitable parallel readings amounting to not less than 500 pages. The examination will call for comparison of historical characters, periods, and events, and in general for the exercise of judgment as well as of memory. Geographical knowledge will be tested by means of an outline map.

As further evidence of the candidate's proficiency satisfactory written work, done at school and certified by the teacher, must be submitted at the time of the examination. It must be presented in the form of a note-book (or bound collection of notes), containing not less than 50 written pages on each historical field offered, and must show practice in some of the following exercises: —

(*a*) Notes and digests of the pupil's reading outside of the text-books.

(*b*) Brief written tests requiring the application to new questions of knowledge previously acquired.

(*c*) Parallels between historical characters or periods.

(*d*) Short studies of topics limited in scope, prepared outside of the class-room and illustrated by some reference to contemporary material.

(*e*) Historical maps or charts showing explorations, migrations, conquests, territorial changes, or social conditions.

In the judgment of the Department of History it is desirable that Greek and Roman History be offered as a part of the preparation of every candidate.

13. *Advanced History.*

Any one of the four courses of study which follow : —

1. Greek History to the destruction of Corinth and Roman History to the death of Constantine (open to those candidates only who have offered English and American History as an elementary study).

2. English History and American History (open to those candidates only who have offered Greek and Roman History as an elementary study).

3. European History from the Germanic conquests to the beginning of the seventeenth century.

4. A year's study of any one of the four historical fields defined under Elementary History and not already offered by the candidate, together with a year's detailed study of a limited period * within that field, selected with the approval of the Department of History.

The examination in the second part of 4 will be specially adapted to the particular period selected and will be held in Cambridge only.

In every case the candidate will be expected to show on examination such an acquaintance with the whole field as may be gained from the study of good text-books, together with substantial parallel readings, and, further, such a detailed knowledge of some part of the field as may be gained from suitable topical study. A higher standard of acquirement and of power to combine results will be expected than in the elementary requirement.

As further evidence of proficiency satisfactory written work, done at school and certified by the teacher, must be submitted at the time of the examination. The form and contents of this written work will be the same as in the elementary requirement, but greater skill in the use of materials and in the statement of results will be expected.

14-17. Mathematics.

A thorough practical acquaintance with ordinary Arithmetic is assumed as underlying all preparation in Mathematics. Knowledge of the fundamental principles of Arithmetic and careful training in accurate computation with whole numbers and with vulgar and decimal fractions form an essential part of early school work. But the pupil's time should not be wasted in the solution by arithmetic of puzzling problems which properly belong to algebra,or in complicated and useless reductions, or in the details of commercial arithmetic. It is desirable that some familiarity with algebraic expressions and symbols, including the methods of solving simple equations, be acquired in connexion with the course in Arithmetic.

Elementary Mathematics.

14. *Elementary Algebra.*—Algebra, through Quadratic Equations. (As at present.)

The requirement in Algebra includes the following subjects : factors, common divisors and multiples, fractions, ratios and proportions ; negative quantities and the interpretation of negative results; the doctrine of exponents; radicals and equations involving radicals; the binomial theorem for positive integral powers of the binomial, and the extraction of roots; putting questions into equations and the reduction of equations; the ordinary methods of elimination and the solution of both numerical and literal equations of the first and second degrees with one or more unknown quantities and of problems leading to such equations.

---

* For example, the Spartan and Theban supremacies, the period of the Punic wars, the Stuart period, the transition from the American colonial to the federal system.

The student should cover carefully the whole ground here specified, and should acquire a thorough understanding not only of the practice, but of the reasons involved in the elementary algebraic rules; for example, in the rules of multiplication, of signs, and of exponents, in the rules for fractions, and in those relating to the reduction and solution of equations. He should train himself to practical skill by the solution of a large number of examples, and should learn to do his work with reasonable quickness, as well as with confidence, accuracy, and clearness. The solution of fairly complicated literal quadratics, the various methods of elimination for equations of the first two degrees, the putting of problems in a neat manner into equations, and the working of the various algebraic operations both for integral and fractional expressions may be mentioned as important subjects of attention. The student should be taught to arrange his work in a clear, orderly, and compact fashion.

The time supposed to be devoted to the systematic study of the requirement in Algebra is the equivalent of a course of three lessons a week through two school years.

15. *Geometry.* — Plane and Solid Geometry, including problems in mensuration of plane and solid figures, and original propositions in Plane Geometry.

Geometric education should begin in the kindergarten or primary school, where the child should acquire familiarity through the senses with simple geometric forms, by inspecting, drawing, modelling, and measuring them, and noting their more obvious relations. This study should be followed, in the grammar school, by systematic instruction in Concrete (or Observational) Geometry, of which geometric drawing should form a part. Such instruction should include the main facts of Plane and Solid Geometry, treated as matters of observation, and not as exercises in logical deduction, without however necessarily excluding the beginnings of deductive proof as soon as the pupil is ready for them. Concrete Geometry is believed to have important educational value, and to prepare an excellent foundation for the later study of Formal Geometry. It belongs, however, to the earlier stages of school work, and should not be postponed until the time that belongs to direct preparation for college or the scientific school.

In teaching Formal Geometry, stress should be laid from the outset on accuracy of statement and elegance of form, as well as on clear and strict reasoning. As soon as the pupil has begun to acquire the art of rigorous demonstration, his work should cease to be merely receptive, he should be trained to devise constructions and demonstrations for himself, and this training should be carried through the whole of the work in Plane Geometry. Teachers are advised, in their selection of a text-book, to choose one having a clear tendency to call out the pupil's own powers of thought, prevent the formation of mechanical habits of study, and encourage the concentration of mind which it is a part of the discipline of mathematical study to foster. The subject of Geometry, not a particular treatise, is what the pupil should be set to learn; and its simpler methods and conceptions should be made a part of his habitual and instinctive thought. Lastly, the pupil should be stimulated to good work by interest in the study felt and exhibited by the teacher.

The requirement in Geometry embraces the following topics: the general properties of plane rectilinear figures; the circle and the measure of angles; similar polygons; areas; regular polygons, and the measure of the circle; the relations of planes and lines in space; the properties and measure of prisms, pyramids, cylinders, and cones; the sphere and the spherical triangle. The propositions required under these several heads are those only which are contained in the older treatises, and which are recognized as constituting the Elements of Geometry. The examination does not include the additions introduced into some recent text-books, although most of those additions are in themselves valuable for the student who has time and taste for extra study in this field. A syllabus of the required propositions is in preparation. It will soon be ready, and may then be obtained upon application.

The examination in Geometry also includes original propositions in Plane Geometry, based on the propositions named in the syllabus, and problems in mensuration in both Plane and Solid Geometry; but excellence in bookwork and in exercises immediately illustrating bookwork will be allowed to offset in part any lack of skill in original work.

The time which it is recommended to assign to the systematic study of the requirement in Formal Geometry is the equivalent of a course of five lessons a week for one school year; but it is believed to be advisable to extend this allowance of time over two years.

15a. *Plane Geometry.* (As at present.)

Until the year 1903 Plane Geometry may be presented instead of Geometry, but it will have less weight in making up the required aggregate of points. This alternative will be withdrawn after 1903.

Advanced Mathematics.

16. *Logarithms and Trigonometry.* — The theory of logarithms and the use of logarithmic tables. — Plane trigonometry. — The solution of the right spherical triangle. — Applications to simple problems.

No technical knowledge of the subjects of surveying and navigation, such, for instance, as the methods of parallel or middle latitude sailing, will be required, but such terms as latitude, longitude, angle of elevation or depression, bearing, etc., should be understood. At the examination, candidates are furnished with four-place tables belonging to the University, and are not allowed to use their own tables. The tables provided are distributed before the hour of examination, so that candidates may have at least an hour for becoming acquainted with their arrangement and use. Teachers who wish a still earlier opportunity of seeing these tables should write to the Corresponding Secretary of the University.

17. *Advanced Algebra.* (Substantially as at present.)

The requirement in Advanced Algebra includes the following subjects:

(*a*) Simultaneous quadratics and equations solved like quadratics; properties of quadratic equations; addition, subtraction, multiplication and division of complex quantities; inequalities; variations; arithmetical and geometrical progressions; mathematical induction; simple problems in choice and chance; continued fractions; scales of notation.

(*b*) Determinants, not including the multiplication theorem; simple applications of determinants to linear equations; the solution of numerical equations of higher degree, and so much of the theory of equations (not including multiple roots or Sturm's theorem) as is necessary for this purpose.

The topics included under (*a*) may be treated briefly. About half the time devoted to the requirements should be spent on the topics included under (*b*).

18–24. Physical Science.

Elementary Physical Science.

18. *Elementary Physics.* — **A course of study dealing with the leading elementary facts and principles of physics, with quantitative laboratory work by the pupil.**

The instruction given in this course should include qualitative lecture-room experiments, and should direct especial attention to the illustrations and applications of physical laws to be found in every-day life. The candidate is required to pass a written examination, the main object of which will be to determine how much he has profited by such instruction. This examination may include numerical problems. It will contain more questions than any one candidate is expected to answer, in order to make allowance for a considerable diversity of instruction in different schools.

The pupil's laboratory work should give practice in the observation and explanation of physical phenomena, some familiarity with methods of measurement, and some training of the hand and the eye in the direction of precision and skill. It should also be regarded as a means of fixing in the mind of the pupil a considerable variety of facts and principles. The candidate is required to pass a laboratory examination, the main object of which will be to determine how much he has profited by such a laboratory course.

The candidate must name as the basis for his laboratory examination at least thirty-five exercises selected from a list of about sixty, described in a publication issued by the University under the title, "Descriptive List of Elementary Exercises in Physics." In this list the divisions are mechanics (including hydrostatics), light, heat, sound, and electricity (with magnetism). At least ten of the exercises selected must be in mechanics. Any one of the four other divisions may be omitted altogether, but each of the three remaining divisions must be represented by at least three exercises.

The candidate is required to present a note-book in which he has recorded the steps and the results of his laboratory exercises, and this note-book must bear the endorsement of his teacher, certifying that the notes are a true record of the pupil's work. It should contain an index of the exercises which it describes. These exercises need not be the same as those upon which the candidate presents himself for the laboratory examination, but should be equivalent to them in amount and grade of quantitative work.

The note-book is required as proof that the candidate has formed the habit of keeping a full and intelligible record of laboratory work through an extended course of experiments, and that his work has been of such a character as to raise a presumption in favor of his preparation for the examination. But much greater weight will be given to the laboratory examination than to the note-book in determining the candidate's attainments in physics. Experience has shown that pupils can make the original record of their observations entirely presentable, so that copying will be unnecessary, and they should in general be required to do so.

This course, if taken in the last year of the candidate's preparation, is expected to occupy in laboratory work, recitations, and lectures, five of the ordinary school periods, about fifty minutes in length, per week for the whole year. With few exceptions exercises like those in the Descriptive List already mentioned can be performed in a single school period, but for satisfactory results it will often be necessary to repeat an exercise. Two periods per week for the year should be sufficient for the laboratory work proper. If the course is begun much earlier than the last year of the candidate's preparation, as it well may be, it will require more time.

19. *Chemistry.* * — A course of at least sixty experiments, performed at school by the pupil and accompanied with systematic instruction in principles and their applications, in accordance with directions given in a pamphlet entitled "An Outline of Requirements in Chemistry," issued by the University for *the use of teachers only.*

The candidate is required to pass both a written and a laboratory examination. The written examination will test his acquaintance with the facts and principles of Chemistry. The laboratory examination will test both his skill in performing experiments and his grasp of the principles involved in them. The candidate is further required to present the original note-book in which he recorded the steps and results of the experiments which he performed at school, and this note-book must bear the endorsement of his teacher, certifying that the notes are a true record of the pupil's work. It should contain an index of the exercises which it describes.

The note-book is required as proof that the candidate has formed the habit of keeping a full and intelligible record of laboratory work through an extended course of experiments, and that his work has been of such a character as to raise a presumption in favor of his preparation for the examination. But much greater weight will be given to the laboratory examination than to the note-book in determining the candidate's attainments in Chemistry.

20. *Physiography.* — A course of study equivalent to that described in a pamphlet entitled "An Outline of Requirements in Physiography," issued by the University.

For the form of examination see note under Astronomy, below.

21. *Anatomy, Physiology, and Hygiene.* † — A course of study and laboratory work equivalent to that described in a pamphlet entitled "An Outline of Requirements in Anatomy, Physiology, and Hygiene," to be issued by the University.

N.B. The definition in this subject has been adopted only provisionally, pending the preparation of the "Outline."

The candidate will be required to pass both a written and a laboratory examination. The written examination will test the range and thoroughness of his knowledge of anatomy, physiology, and hygiene. The laboratory examination will test (*a*) his practical familiarity with the simpler manipulations of the compound microscope and his ability to recognize the principal histological tissues; (*b*) his acquaintance with ordinary chemical tests for the common food-constituents and digestive products; (*c*) his knowledge of the first aids to be rendered in emergencies.

At the time of the written examination the candidate must present the original note-book containing (with dates) the notes and drawings he has made in the course of his laboratory work, and bearing the endorsement of his teacher, certifying that the book is a true record of the pupil's own observations and experiments. An index of subjects should be appended.

---

* Equivalent to Chemistry *B*. The course will be mainly an experimental course in theoretical chemistry, but there will be experiments covering all branches of pure chemistry.

† Equivalent to Hygiene 1 *hf.*

Advanced Physical Science.

22. *Advanced Physics.*[*] (Substantially as at present.)

The University does not prescribe the experiments to be performed by those offering this subject for admission. The work should, however, be of advanced grade, almost wholly quantitative, and conducted with apparatus, not necessarily elaborate, yet capable, if carefully handled, of yielding results of such accuracy as to warrant the consideration of somewhat minute error. For example, the balance used in weighing should be so delicate as to justify corrections for the buoyancy of the air on the weights and on the body weighed, and, in the determination of specific gravity, for the temperature of the water. The results should be discussed with reference to their precision and to the number of significant figures. There should be about sixty experiments well distributed through the range of general physics. If the student has devoted a considerable amount of time in the elementary course to experiments in heat, that division of physics may be here omitted. The laboratory work can be performed properly only in periods of considerable length, two to four hours, for example.

Instruction by lectures or text-books and work in problems should be a part of the course.

The candidate will be required to pass both a laboratory and a written examination. He should so thoroughly understand the work which he has performed as not to be confused in the laboratory examination by unfamiliar forms of apparatus.

The laboratory note-book will receive careful attention at the time of the examination. It must contain a certificate from the teacher that it is a true record of the candidate's work.

23. *Meteorology.* — A course of observational study equivalent to that described in a pamphlet entitled "An Outline of Requirements in Meteorology," issued by the University.

This course requires a knowledge of Elementary Physics. (For the form of examination see under Astronomy, below.)

24. *Astronomy.* — A course of observational study equivalent to that described in a pamphlet entitled "An Outline of Requirements in Astronomy," issued by the University.

This course requires a knowledge of Geometry.

In Physiography, Meteorology, and Astronomy, the candidate will be required to take both a written and a laboratory or practical examination. The written examination may test his understanding of observational methods appropriate to the subject, but will call chiefly for a knowledge of facts and principles. The laboratory or practical examination will test his skill in observation as well as his grasp of principles. This examination can be taken in Cambridge only; for those who are examined elsewhere in June, it will be postponed to September.

The laboratory examination in Physiography may include the description, explanation, and comparison of geographical features shown in photographs, maps, and models. The laboratory examination in Meteorology may include the use of instruments, the discussion of observations, and the construction and interpretation of weather maps and climatic charts. The practical examination in Astronomy may call for an ability to make simple naked-eye and instrumental observations, and to establish the simpler generalizations of astronomy by discussion of these observations.

---

[*] Equivalent to, but not necessarily identical with, Physics *C*.

The candidate in these subjects will be required to present, at the time of the laboratory or practical examination, the original note-book in which he recorded, with dates, the steps and results of the observations which he made at school. This book must bear the endorsement of his teacher, certifying that the notes are a true record of the pupil's work. An index of subjects should be appended. The note-book is required as proof that the candidate has formed the habit of keeping a full and intelligible record of his work through an extended course of observational study, and that his work has been of a satisfactory character; but greater weight will be given to the practical or laboratory examination than to the note-book in determinng the candidate's attainments.

The following studies may be presented by candidates for admission to the Lawrence Scientific School: —

25, 26. Botany and Zoölogy.

25. *Botany.* — A course of study and laboratory work equivalent to that indicated in an "Outline of Requirements in Botany," issued by the University. The course should extend through at least half of a school year, with five lessons a week. The laboratory work is to be directed especially to the external anatomy and the activities of our common plants.

26. *Zoölogy.* — A course of study and laboratory work equivalent to that described in a pamphlet entitled "An Outline of Requirements in Zoölogy," issued by the University. The course should extend through at least half of a school year, with five lessons a week, and should include the laboratory study of at least ten types of animals, with special reference to their external anatomy and their activities. These types are to be selected in accordance with directions to be given in the pamphlet named.

In Botany and in Zoölogy the candidate will be required to pass both a written and a laboratory examination. The written examination will test the range and thoroughness of his knowledge of the subject. The laboratory examination will test his skill in observation and experimentation, and his ability to apply names properly to the parts of the organisms studied.

At the time of the written examination the candidate must present the original note-book containing (with dates) the notes and drawings he has made in the course of his laboratory work, and bearing the endorsement of his teacher, certifying that the book is a true record of the pupil's own observations and experiments. An index of subjects should be appended.

27-30. Shopwork.*

A course of instruction in the use of tools and in the ordinary processes employed in the working of wood or metal, equivalent to that described in a pamphlet entitled "An Outline of Requirements in Shopwork," issued

---

* Each of the courses numbered 27-30 is to be equivalent to a half-course in the Lawrence Scientific School.